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SEAs Successful as Alien Species Controls

By Tim Tunison and Chris Zimmer

Alien species pose a critical threat to native biota in Hawaii; already they have altered many ecosystems at Hawaii Volcanoes NP. Special Ecological Areas (SEAs) are intensive management units in which alien species control that is not affordable or feasible on a parkwide basis is conducted. (Tunison et al. 1986). An SEA approach has guided alien plant management since 1985 and this report evaluates its success in controlling alien vegetation.

Alien Species Threats

Ecosystems of remote islands such as Hawaii are especially vulnerable to alien species invasions (Loope and Mueller-Dombois 1989). The native biota have evolved free from disturbance factors such as ungulates and fire. Feral ungulates and alien plants have altered much of the natural vegetation of Hawaii Volcanoes NP and feral goats have devastated large portions of the coastal lowland zone by preferentially grazing on native species. .

Feral pigs disturb soil, disrupt the understory in wet and mesic forest, and disperse the seeds of exotic plants. Over 35 (of 600) non-native plant species in the park can be considered to be habitat-disruptive. Some of these form mono-specific stands. Others alter fire, nutrient, and soil-moisture regimes (Smith 1985).

The SEA Approach to Management

The Special Ecological Area concept developed out of the need to protect immediately some of the most biologically valuable sites in the park from alien plants while these still were manageable. SEAs were selected largely on the basis of intactness, manageability, species richness, immediacy of alien plant threats, and presence of rare flora. Other factors included potential for research and interpretation, uniqueness, preserve design considerations, and need for experimental management.

An attempt was made to locate SEAs in all six ecological zones in the park, to make them as large as possible, and to link them in some fashion. SEA management demonstrates the park's decision to solve weed problems systematically and incrementally. SEAs are intended as models for management of other areas. As alien species are reduced to management levels and workload requirements drop, SEAs are expanded and new SEAs started.

All disruptive alien plants, even those targeted for biological control research, are controlled by manual, mechanical, or herbicidal means in SEAs. Many of these cannot be controlled parkwide because they are too widespread. Feral ungulates generally are controlled in larger units that include the SEAs.

SEAs also are foci for research and interpretation. An understanding of Hawaiian biota and ecosystems is

(Continued on page 3)



***Using a periscope device**, Julie Leialoha, Biological Technician, measures canopy cover in a tree-fern dominated rain forest site recovering from feral pig damage and following removal of alien plants. Monitoring is an integral component of alien plant control efforts in SEAs. Population levels of target plants are monitored along extensive belt transects. Intensive plots are located randomly in recovering sites of special interest to evaluate total vegetation changes.*

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Native Plants Delight Visitors at Columbia Gorge Plot

Editor's Note: Material for this article was provided by Berta Youtie – all except the parts that say what a whale of a job she did.

It all goes to show that information collected at a site where it "didn't work out" can sometimes be put to excellent use at a different site.

Berta Youtie, The Nature Conservancy's land steward for Oregon's Governor Tom McCall Preserve, located within the Columbia River Gorge National Scenic Area, once worked for the National Park Service investigating techniques to restore the overgrazed ranches that comprise the John Day Fossil Beds National Monument in arid Eastern Oregon. Collecting seeds from the site, growing bunchgrass plugs in the greenhouse, and then transplanting them to the field was found to be very successful on a small scale, but wasn't considered feasible on the Monument's large scale.

That was back in 1981. Today is another site and another story – this one with a happier ending.

The site in question is two acres of what is called "disturbed habitat" – in this case, a somewhat euphemistic term for part of a parking area that had become almost rock-hard by compaction. Today, because Berta Youtie saw the possibilities and remembered the techniques, the site is drawing the admiration of Gorge visitors who pause there to see the recently established display of wildflowers. The area now is a native plant garden, being used as an interpretive tool to heighten people's appreciation for the natural beauty of native species and to teach the art and science of restoration ecology.

The preserve is located on a plateau between Hood River and The Dallas and is home to more than 300 species of plants. They grow among the oak savanna, vernal pools, rocky basalt cliffs, biscuit scablands, and

Table 1. Native plant material used at the Rowena Crest Native Plant Garden in 1990.

Species	Habitat	Propagule	Survival*
Grasses			
Agropyron spicatum	mound	seed	+
Festuca Idahoensis	mound	seed	+
Stipa lemmoni	mound	seed	+
Sitanion hystrix	scab	seed	+
Shrubs			
Rosa nutkana	scab	cutting	+
Holodiscus discolor	scab	cutting	+
Philadelphus lewisii	scab	cutting	+
Forbs			
Balsamorhiza careyana	mound	plant	+
Eriogonum compositum	scab	cutting	+
Eriogonum strictum	scab	cutting	+
Eriophylum lanatum	scab	plant & seed	+
Lomatium columbiana	mound	seed	–
Lomatium dissectum	mound	seed	–
Lomatium grayi	scab	seed	–
Lomatium nudicaule	scab	seed	–
Lupinus latifolius	mound	seed	+
Penstemon richarsonii	scab	plant	+
Phacelia hastata	scab	plant	+

*Survival = + majority of plants survived first year
– majority of plants did not survive
? too early to judge



***Volunteers dig in** to the job of introducing native transplants.*

SEAs Successful

(Continued from page 3)

management; the approach also has protected the most important sites in the park. Population levels of target species have declined markedly, typically by an order of magnitude, in spite of some recruitment from surrounding areas. Workloads have decreased by a factor of five. Hawaii Volcanoes NP will continue the SEA approach to management, and encourages this incremental, experimental strategy for parks and preserves where alien species or native ecosystem restoration problems are overwhelming.

Tunison is a Resource Management Specialist in charge of the vegetation management program at Hawaii Volcanoes NP; Zimmer is field supervisor for the alien plant control program.

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"... by applying molecular biology to the study of evolution, taxonomic sleuths have identified two California cousins of the Hawaiian silversword 'alliance,' a grouping of 28 closely related plants. The findings also furnish genetic clues suggesting that all existing silversword species may have evolved from a single seed. Plant evolutionist Bruce G. Baldwin suspects the genealogic evidence he has collected may even inspire new thinking about how plants worldwide 'came to be where they are'."

"From Tarweed to Silversword" is the title of an article by Wendy Gibbons in the April 27, 1991 issue of *Science News*, suggesting that Hawaiian plants with California roots "challenge botanical dogma." Researchers Donald W. Kyhos of U/CA Davis and Gerald D. Carr of U/HI Honolulu attempted to confirm the apparent kinship between a Hawaiian silversword specimen and two California tarweeds with sets of mutations closely resembling those of the Hawaiian plants by crossing them. "We could hardly believe our eyes when the results came in," Kyhos said. The matings produced healthy hybrid plants, suggesting that a single tarweed progenitor established itself on one Hawaiian island and that subsequent generations from that single plant "probably evolved into the diverse group of silverswords now evident in Hawaii."

Columbia Gorge Native Plants Plot *(Continued from page 4)*

grassy slopes. The Nature Conservancy joined forces with Oregon State Parks and other local organizations to work their restoration miracle.

Permission for the project was obtained from the USFS, Columbia Gorge Commission, Citizen's Advisory Board for the Columbia River Gorge Scenic Highway (and of course Oregon State Parks). Last year, TNC won an award from the Oregon Native Plant Society in "the best use of native plants" category.

Landscape gardener Michelle Zimmerman initially designed the garden with some subsequent redesign from Kathy Schuttt, a landscape architect for Oregon State Parks. Before planting, it was necessary to recreate the natural mounded prairie topography of the previously leveled site. The Oregon Highway Department provided much of the construction means – heavy equipment, as well as volunteers with shovels and rakes for shaping and grading the mound surfaces.

Seeds of forbs and bunchgrass species (Table 1) were collected in the summer of 1989 from adjacent areas. Local Portland garden organizations experimented with scarification techniques for wildflower species and grew seedlings in their greenhouses. Balsamroot transplanting occurred from the wild. Small plants were removed from an area designated for development. More than 90 percent of the 200 transplants have survived the first two years. Bunchgrass seedlings were propagated in greenhouses. Shrub cuttings also were planted on the site.

Small signs now identify the scientific and common names of the plants and an interpretive sign is being created to promote understanding of restoration using native plants.

With survival having been overwhelmingly successful, the site was dedicated on June 16, 1991, to Robert Ellis, a conservationist and member of the Oregon Roadside Council.

A handy, well-illustrated visitor brochure describes the Tom McCall Preserve, its early history, geology, vegetation, wildlife, and management, and highlights "guidelines for use."

Although the National Park Service is not among those listed in the "credits," Berta Youtie's work, arranged through the NPS/CPSU at Oregon State University, remains a solid underpinning for this recent attestation to the value of Cooperative Park Study Units and to the far-flung successes that sometimes stem from seeming failures.



***This lush growth** of bunchgrass seems to be waving enthusiastic thanks to the volunteers who helped restore it.*


COOPERATIVE NATIVE PLANT RESTORATION PROJECT
Visitors are invited to observe the wildflowers, but are reminded to please stay on the trails to assure a successful restoration garden.
The Nature Conservancy
Oregon State Parks
Oregon State Highway Division
Oregon Roadside Council
Portland Garden Club
Berry Botanic Garden
Oregon Native Plant Society

More signing is planned to interpret the area as well as sharing the credit.

NPS and SCS Cooperate On Native Plant Materials Program

By William R. Beavers and Wendell G. Hassell

The National Park System of the United States comprises 356 areas covering almost 80 million acres in 49 states, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. The diversity of the System is relfected in the variety of the park unit titles.

The National Park Service's mandate to preserve resources while providing for public enjoyment, faces park adminstrators with a delicate balancing act. Revegetation and reclamation activities present special problems for those trying to maintain native plant populations in areas impacted by visitor facilities.

To the extent possible, plantings in park units consist of species that are native to the park or are historically appropriate for the event commemorated. To this end, a cooperative agreement between the NPS and the Soil Conservation Service (SCS) was developed in 1989. This Plant Materials Program seeks to draw upon the strengths of the two federal agencies in the development, testing, and establishment of native species for disturbed sites within NPS units (see ***Park Science***, 11:3, p.7).

Program Development

The plant materials program between the two agencies initially focused on development of native plants for the revegetation of areas disturbed by road construction. The park roads program is the ideal starting point for the plant material program. Since advancedscheduling and funding appropriations are critical to the success of this program, the park roads program assures that all plant materials projects can be funded adequately and that sufficient lead time will be available to complete plant production schedules.

The SCS maintains 26 plant material centers throughout the United States, including Alaska and Hawaii. Each center is located to take advantage of common characteristics of climate, topography, and soils in parts of two or more states. They are at Pullman, WA; Corvallis, OR; Lockeford, CA; Aberdeen, ID; Tucson, AZ; Meeker, CO; Los Lomas, NM; Bridger, MT; Bismarck, ND; Manhattan, KS; Knox City, Nacogdoches, and Kingsville, TX; Elsberry, MO; Boonesville, AR; Golden Meadow, LA; Jackson, MS; Quicksand, KY; Rose Lake, MI; Americus, GA; Brooksville, FL; Big Flats, NY; Cape May, NJ; Palmer, AK; and Hoolehua, HI. The National Plant Materials Center is in Beltsville, MD.

Current Programs

Presently, the NPS and SCS have developed plant materials agreements for 20 park road projects. In addition, a parkwide plant materials program is under development within the Rocky Mountain Region of the NPS and will be implemented in selected parks before the end of the year. Within the next 5 years, the plant materials program can be expected to grow, addressing needs in over 40 parks. The plant program and information generated over the coming years will add to the information base and help develop park indigenous species that are locally adaptive. This program also will provide the needed reclamation technolgies to develop successful revegetation techniques in reestablishing these native park species.

Beavers and Hassell are National Technical Advisors for Plant Materials for the NPS and SCS respectively. Beavers may be contacted at (303) 969-2734.

Great Basin To Test Electronic "Ear Ring" As Cattle Control

By William Brock, Arthur Tiedemann and Thomas Quigley

The enabling legislation that created Great Basin NP identified livestock grazing as an appropriate historic use and its continuation was specifically enacted "subject to constraints imposed by the Secretary to ensure proper rangeland management practices."

The environs of Great Basin NP, as well as of many other areas of the intermountain west, have been considerably altered by expansive livestock production which began in the early 1900s (Young et al. 1978). Contributing factors of fire suppression and perhaps climate change have interacted with grazing to cause an increase in upland woody plant cover. This has reduced upland forage productivity, forcing cattle to concentrate in limited and highly sensitive riparian areas.

At Great Basin NP, riparian habitats extend over an approximate 1320 m elevational gradient from 1850 m to 3170 m (Murray and Smith 1990). Although riparian habitats comprise only a small proportion of the total park area, they are the nucleus of the greatest diversity and highest productivity. These areas provide a direct physical and biological link between different community types (Brown 1982), as well as providing food, water, and breeding site resources for resident and migratory wildlife. Livestock grazing, and particularly intensive, protracted use, can have an adverse effect on riparian vegetation structure and function, soil stability, and water quality. Controlling livestock use in these critical areas is a priority management need.

Section 319(h) of the Clean Water Act provides 60 percent matching funding to qualified State sponsored projects. These grants are awarded to projects specifically focused on developing new technologies leading to best management practices for non-point source water pollution problems. Great Basin NP, in cooperation with the USFS Pacific Northwest Research Station, Oregon State University, the Texas Agricultural Extension Service, and Baker Ranches, Inc., has secured $251,000 in project support through a Section 319(h) funding proposal to develop and test management alternatives to fencing, for controlling livestock use in sensitive riparian areas.

The technology involves using an electrical stimulus from specially designed ear tags to achieve animal avoidance of designated exclusion areas. The basic concept is that an animal can be controlled by electrical stimulation to the ear as the animal enters the zone of influence of a signal from a remote, battery powered transmitter installed in the area of desired exclusion. Funding for this project will support the development of prototype electronic ear tags and transmitters, controlled experiments on effectiveness, and field trials in Texas and Great Basin NP.

We anticipate that the results of this project will point the way for accelerated development and distribution of a new "best management practice" for controlling livestock movement on rangelands and pasturelands, resulting in improved riparian management and water quality. If successful, this technology will have application not only to the 27 NPS areas that currently authorize livestock grazing, but also to other NPS situations unrelated to livestock management.

The project is scheduled for completion in September 1992.

Brock is Resource Management Specialist at Great Basin NP; Tiedemann is Chief Ecologist and Quigley is a Range Scientist with the USFS PNW Research Station.

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Colorado Plateau NPs Hold First Biennial Science Conference

The First Biennial Conference on Research in Colorado Plateau NPs, held July 22-24 on the Flagstaff campus of Northern Arizona University, comprised 39 presentations. They covered the entire range of plateau park research, from grazing impacts through birds and fish, mammals, geology, archeology, sociology, hydrology, air quality, vegetation, and Geographic Information Systems.

John Davis, who will soon be leaving the superintendency of Grand Canyon NP for Washington, D.C.,to become NPS A/D for Operations, welcomed the conferees, as did Patricia Reed, NAU vice-president of academic affairs.

NPS A/D for Natural Resources Eugene Hester flew in from Washington to congratulate the gathering on the biogeographic approach that has been taken by Colorado plateau parks research. (See editorial). Bruce Kilgore, Western Regional Chief Scientist, described the history of the recently established NAU Cooperative Park Studies Unit (CPSU) and the role of its leader, Charles van Riper III, in conceptualizing and establishing the science program. The Unit's holistic approach to research and problem-solving in a biogeographic region of related problems and resources has been responsible, Kilgore said, for support from two, and possibly three NPS Regions – something that has never happened before in NPS history.

(The Unit is based in the Western Region, enjoys Rocky Mountain Region support, and may soon receive additional support from the Southwest Region.)

Dan Huff, Rocky Mountain Regional Chief Scientist, spoke of the need for a synergy of management and its concomitant need – a synergy of science. The double-barreled NPS mission, to maintain ecological preserves and to serve as a recreation agency, demands the best in natural and social science research, Huff said, "and if you don't *like* this problem," he added;, "I can only quote Barbee [Yellowstone NP Supt. Robert Barbee]: 'The U.S. Postal Service needs a few good people.'"

Following the plenary session, at which John Cherry, Assoc. Director of the Western Region; Homer Rouse, Assoc. Director of the Rocky Mountain Region, Henry Hooper, Assoc. V-P of Academic Affairs at NAU, and van Riper, all spoke, the three-day session went into high gear. Many of the studies presented will appear in future issues of *Park Science*.

A lively symposium on air quality brought all the conferees together for two hours on the second morning. Roger Clark, director of research for the Grand Canyon Trust, chaired a panel of five: John C. Freemuth of Boise State University; C.V. Mathai, principal scientist for Arizona Public Service; Linda Mazzu, Grand Canyon NP Resource Management Specialist; Debra Mangis of the NPS Air Quality Division, Denver; and Ken Luckow, Air Quality Specialist for the USFS, Region IV, AZ.

Visitor concern over the high profile problem of visibility in parks was cited as factor in the heightening of general public concern over air quality. Mathai maintained that "one point source alone isn't responsible for all the lowered air quality. Electric generators," he said, "are highly visible point sources. But they are furnishing things the public also wants, and *society* must make a decision as to how much it is willing to let rates rise in order to provide cleaner air."

Luckow responded that the Clean Air Act already reflects society's decision that air must be cleaned up. Mathai responded that "the Act also states specifically that costs to point sources must be justified by cost/benefit ratios."

The conference was hosted and organized by the NAU/CPSU and co-sponsored by Bryce Canyon Natural History Assn., the Petrified Forest Museum Assn., and Zion Natural History Assn. Van Riper, the NAU Unit Leader, served as Conference chair; Mark Sogge was conference leader.

A program containing abstracts of presented posters and papers is available from the NAU/CPSU, Flagstaff, AZ 86002; (602) 523-9080

Jean Matthews, Editor
Park Science

A Slice of Parks' Future?

Conservation in Regional Landscapes is the title of a graduate course at U/Cal Davis, designed and taught last winter term by NPS research scientist Christine Schonewald-Cox with four of her colleagues. The course focused on habitat conservation on a broad regional scale, using the Sacramento valley as subject area and zeroing in on two main objectives:

1. To see what capacity this region has to protect biodiversity taking into account theory in biogeography, population biology, evolution, landscape ecology, and emerging conservation biology, and

2. To examine how the presence of humanly modified landscapes, culture, human demographic changes, and law place constraints on the direct application of theoretical principles.

The class was charged with trying to integrate theory and practice in the planning of regionwide habitat protection. Schonewald-Cox sees the valley as the "connector" between the coastal range and the sierra and suggests that in the urbanized sections "we can see the forerunners of conditions that will likely surround many of our presently remote parks."

Gypsy Moths May Alter Black Bear Population Dynamics In Shenandoah National Park

By Michael R. Vaughan and John Karish

Shenandoah NP (SNP) is home to what likely is one of the densest black bear (*Ursus americanus*) populations in the conterminous United States (Carney 1985). However, recent invasion of the park by gypsy moths (*Lymantria dispar*) threatens the continued stability of the bear population.

When the 777 km2 park (Fig. 1) was established in 1935 in the Blue Ridge Mountains of northern Virginia, it was largely deforested due to homesteading (Mazzeo 1979), and black bears reportedly were observed infrequently. But with protection from hunting and favorable habitat changes, the population apparently increased quickly. By the mid-1970s, it had reached a reported density of one bear per 2.6 km2 (Raybourne 1976, Dubrock 1980). With construction of Skyline Drive and improvement of park visitor facilities, human visitation also increased, and bear/human interactions became an issue (Garner and Vaughan 1989). Bear damage to property adjoining the park also increased.

In response, the park implemented a bear management plan in 1976 with goals of (1) restoring and maintaining the natural integrity, distribution, and behavior of the bear population, (2), minimizing nuisance bear conflicts, and (3) providing visitors the opportunity to view bears in a natural setting. The plan called for a number of practices aimed at reducing front country use by bears, plus research on the bear population that would provide information essential for dealing effectively with this valuable resource.

In 1982 the NPS established an interagency agreement with the Virginia Cooperative Fish and Wildlife Research Unit at Virginia Polytechnic Institute and State University to study the black bear population at SNP. This long-term project, still in progress, had as its initial objective to determine demographic characteristics of the park's bear population and to describe movement, distribution, and habitat use patterns. More recently, research has focused on effects of gypsy moth induced defoliation on the bear population. Thus far, four graduate students, several technicians, and numerous volunteers have participated in the research.

Demographics

The bear research started with an intensive capture and marking program. From April 1982 through November 1983, 115 different bears were captured 149 times in the 298 km2 Central District study area (Fig. 1), and 47 were equipped with radio transmitters. The overall sex ratio of first-time captures was 2.03 males per female. However, for adult bears (estimated by tooth sectioning to be >3 years old) and for subadults (1-3 years old) the ratios were 1.3 and 3.8 males per female, respectively.

While it is generally accepted that males are more vulnerable to trapping than females and may be captured 1.5 to 2.5 times as frequently as females, the greatly disproportionate ratios for subadults and the similarity of capture frequencies for adult males and females was an indication of an unusual age distribution for SNP bears. The average age of captured females was 5.1 ($N = 36$) while for males it was 3.2 ($N = 76$). Bears less than 1 year old ($N = 3$) were excluded from sex and age ratio analyses.

In the first three years of study about 50 percent of marked bears denned on the ground. Ground dens

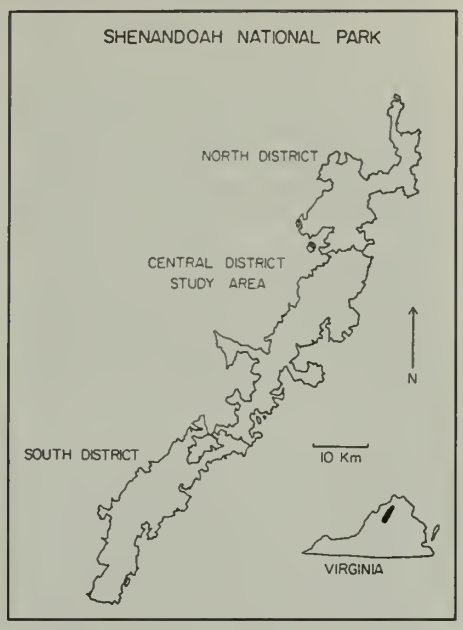


Figure 1.

and, where possible, tree dens were checked in late winter prior to emergence to determine reproductive effort. The average litter size of 21 reproductive females was 2.0. No females produced more than 3 cubs per litter during the initial study, although the first litter of 4 in SNP was recorded in 1990. All but 2 reproductive females were estimated to be at least 4 years old when they gave birth. The 2 exceptions were estimated to be 3 years old when they gave birth, meaning they had bred at 2 years of age. Generally, females gave birth every second year unless they lost their entire litters during the summer, in which case they gave birth in consecutive years.

Forty-four of the 47 radio equipped bears were adults and 28 of the 44 were alive at the end of the study. The remaining 16 were legally (7) or illegally (5) harvested, disappeared (3), or were removed (1) because of nuisance activity. The annual adult male mortality rate was 41 percent; the adult female mortality rate was only 7 percent.

The capture data were processed through programs CAPTURE and JOLLY to estimate bear density in the central district of SNP. The estimated density (an average of all estimators) ranged from 0.67 to 1.04 bears per square kilometer (1.7 to 2.7 bears/mi2). This extremely high bear density represents one of the highest density estimates reported in North America.

Contributory Factors

Why does SNP have such a high bear density? Probably several factors contibute. The area was a mosaic of homesteads prior to becoming a national park, and most of these old home sites had fruit trees (apple, cherry, pear) growing nearby. Our investigation of old home sites and bear movements (Garner 1986) indicated that these sites produced substantial amounts of fruit and were important to bears, particularly in late summer and early fall. In addition, natural food supplies were abundant. Although we made no quantitive measures of food availability, we noted good production of berries and forbs in summer months, and cherries, grapes and acorns in the fall.

The forest in SNP is over 70 percent oak and normally produces high quantities of acorns, which made up almost 50 percent of the bears' annual diet. (Fig. 2). Thus, the park appears capable of supporting a high number of bears. The discovery of a high degree of home range overlap among adult female bears (up to 90%) further strengthened the conclusion that food was abundant.

The sex and age ratios, average ages of male *vs* female bears, and differences in mortality rates of male *vs* female bears, all suggested that the male segment of the population was exploited while the female segment appeared not to be exploited. When we examined bear movements we found that females rarely left the park (15% of location out of the park) while males were twice as likely (32%) to be out of the park. When adult males were outside the park they suffered high mortality from poaching and legal harvest (we did not radio tag subadult males and do not know how frequently they left the park or their mortality rate).

(Continued on page 8)

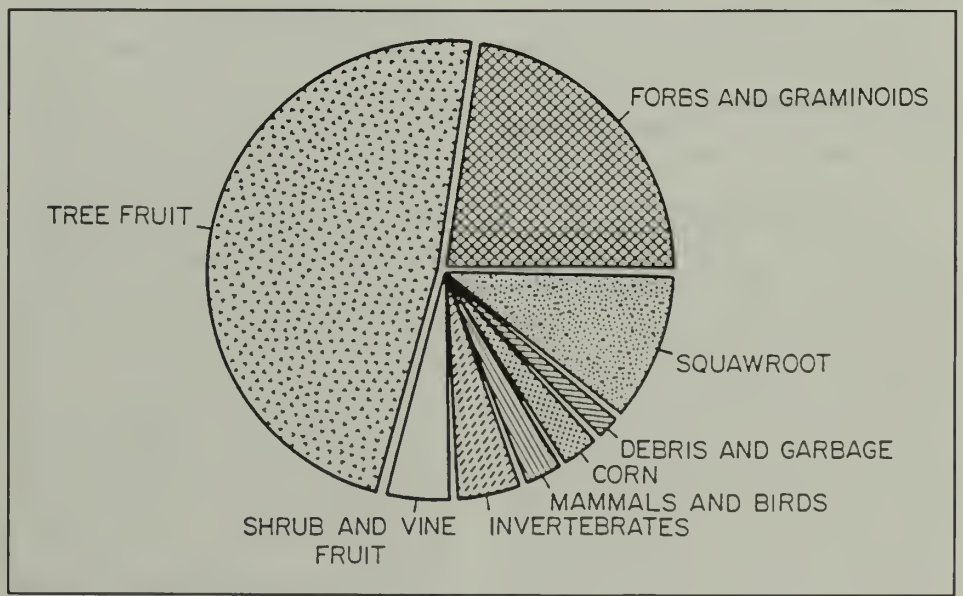


Figure 2.

letters

To the Editor:

John W. Laundre, "Mountain Goats in Yellowstone" (***Park Science***, Summer 1991), states that there is no historical evidence for mountain goats in Yellowstone NP. His bibliography, however, gives no indication that archaeological data from Yellowstone NP were consulted in this study. Archaeology is an ideal tool for the research biologist in determining environmental circumstances of the past.

Michael P. Sampson, State Archeologist
California Dept. of Parks & Recreation

Further Word From Mary K. Black

To the Editor:

I was perhaps not clear enough in my letter. When I said the killing of wildlife was "philosophically out of context for the NPS," I meant in an ethical, not a policy, sense. This is especially important for the perception the general public has of the Park Serivce. Further, whether Theodore Roosevelt was a "mighty hunter" does not dispel the increasing public criticism of the so-called National Wildlife Refuge System.

Living by another's rules is not a sound basis for a personal philosophy, nor an escape from personal assessment of one's actions. I am sorry Mr. Lovaas is "disturbed" that I do not believe he cares deeply for wildlife. If reveling in the wild spirit of an animal and the wilderness that nurtured it – while gratuitously taking its life and devouring it – is a mark of caring deeply for nonhuman animals, then disturbed he shall remain.

Mary Kelly Black, Staff, *Women's Rights NHP*

Mountain Lion-Human Interaction Studied

By Katherine L. Jope

Numerous mountain lion incidents, resulting in hum an injury, have occurred throughout the West with increasing frequency in recent years. To help address this growing problem, a workshop on interactions between mountain lions and people was held in Denver on April 24-26, hosted by the Colorado Division of Wildlife.

The workshop was co-sponsored by the NPS, USFWS, USFS, USDA Extension Service, BLM, and the Colorado Chapter of the Wildlife Society, plus 14 state and provincial wildlife agencies. The purpose of the workshop, attended by about 300, was to bring people together and search for patterns in the incidents.

Incidents seem to occur most often where suburban developments are expanding into mountain lion habitat. Other factors that appear to contribute to the likelihood of incidents are (1) residents feeding deer; (2) high deer populations; (3) people keeping dogs, cats, ducks, geese, or other small animals outdoors, and (4) keeping pet food outdoors.

Incidents involving hikers and joggers have occurred primarily in areas where deer populations are high. The presence of a dog seems to contribute to likelihood of attack. Children are victims more often than adults.

Evidence supports a theory that intensive hunting contributes to the likelihood of attacks. Since most mountain lion hunting is done using packs of hounds, the lions most likely to escape are the more aggressive ones, while the more passive mountain lions are removed. The consequence of this selection may be a population with a tendency toward more aggressive behavior. Of the 50 injury attacks recorded, 29 occurred in British Columbia, where there is intensive hunting.

The behavior displayed in these incidents is typical predatory behavior. There is little doubt that the intent is to prey on the person or domestic animal involved. Any person who encounters a mountain lion that does not run away should treat the situation as threatening. The recommendation is for the person threatened to behave as aggressively as possible, trying to appear dangerous to the mountain lion.

There was some tendency for dispersing yearlings to be involved in incidents more than adult mountain lions. No association was found with abnormalities such as disease or starvation.

Jope is Regional Resource Management Specialist at NPS/PNRO in Seattle, WA.

Gypsy Moths Affect Bear Populations at Shenandoah *(Continued from page 7)*

This discovery helped explain why the average age of male bears on the park was so low and why adult males showed up in the trapped sample in lower proportion than expected. It also suggested why so many juvenile males were trapped in the park. Kemp (1976) earlier showed that by selectively removing adult males from a population of bears in Alberta, Canada, population size increased as several young males moved i8nto the territory vacated by each larger adult male. Adult males are believed to be important in regulating bear populations by killing excess cubs and yearlings and by forcing young males to leave the population (forced egress).

Thus, we believe that the high density bear population in SNP is due to (1) an abundant food supply which enhances reproduction and survival and allows bears to tolerate extensive home range overlap; and (2) exploitation of the adult male segment of the population, which lessens their regulatory influence.

Enter the Gypsy Moth

As we concluded the demographic and habitat relations portions of our study in 1985, gypsy moths began to appear in the park. These insects can defoliate large areas of oak (and other) trees, resulting in loss of acorn production (McConnel 1988). Since bears in SNP depend heavily on acorns (Fig. 2), the NPS decided to continue bear research to determine how environmental perturbations caused by gypsy moths impacted the bear population. Likely short term impacts included changes in food habitats, changes in movement and distribution patterns, increased depredations by bears in areas adjacent to the park, and increased harvest of bears as they moved off the park in search of food. Predicted long-term impacts included reduced reproduction and survival because of poor nutrition, and thus a reduced population level.

Defoliation in 1985 was light, but in 1986, 1987, 1988, 1989, and 1990, 551 ha, 2,633 ha, 6,500 ha, 17,400 ha, and 15,891 ha respectively, were defoliated within the park. Acorn production in defoliated stands from 1987-1990 was essentially nonexistent (McConnel 1988, Ksbohm and Vaughan 1990) and bears in those stands had to use alternative food sources or move during the fall hyperphagic (over-eating) stage.

Because defoliation opens up the forest canopy, some soft mast crops, grape in particular, were abundant in defoliated stands and bears fed heavily on them. Some long-range movements (>10 km) were recorded, but without complete data analysis it is not clear at this time if all movements were related to defoliation. Reproduction has remained good, but there are preliminary indications that cub survival may be down. Data from the initial four years of defoliation related research is being analyzed and data collection for the final year of field study soon will begin.

Nine years of research on the SNP bear population has provided valuable information to the NPS and to the Virginia Department of Game and Inland Fisheries (VDGIF). For the NPS, the research has provided demographic and bear/habitat relationship information, identified areas of SNP important to bears, and allowed SNP Resource Management personnel to develop a management strategy for park bears. The VDGIF has benefitted from the research because SNP serves as a reservoir of bear reproduction, and those that spill out of the park are available for harvest. More than 50 percent of the bears harvested in Virginia (614 in 1990) were harvested from the eight counties in which SNP lies.

The current gypsy moth/bear interaction study will be useful not only to the NPS but to other agencies trying to predict how loss of acorn crops will impact wildlife populations dependent on this valuable resource. SNP has provided a unique opportunity to study (1) the potential of a bear population under natural conditions, (2) the effects of a natural disaster (gypsy moth) on the bear population, and (3) the interactions that occur at the interface between a national park and the adjacent private land.

Karish is Chief Scientist for the NPS Mid-Atlantic Region; Vaughan is Asst. Leader, F&W Coop. Research Unit at VA Tech.

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notes from abroad

Editor's Note: Grassland and prairie management in the United States and England, similarities and differences in approach, is the subject of this issue's Notes from Abroad. Dr. Jackson, Professor of Biology at Missouri Southern State College in Joplin, spent a year's sabbatical as Visiting Scholar at Wolfson College, Oxford University. Hearn is Adviser on Nature Conservation with the Estates Advisers Office, The National Trust, Cirencester, Gloucestershire, England. Jackson is a Cooperative Researcher and has done limestone glades prairie research for the NPS at Wilson's Creek National Battlefield in Missouri.

By James R. Jackson and Katherine A. Hearn

After working separately for over 10 years on grassland management at historic sites for the Midwest Region of the National Park Service in the U.S. and for the National Trust in England, we now are working together on grassland management in England. We have realized that there are some interesting similarities and differences in our approach to grassland management. The areas most interesting for comparison are: threats to the grasslands, serious management problems, differences in management practices, areas needing more research, and the development of management objectives for grasslands.

In the United States and in England the most important threat to grasslands is their loss to agricultural practices. This problem is more acute in England than in the U.S. for several reasons. England is a small country by U.S. standards and there are not vast proportions of the country that have historically been grassland. Also, during the Second World War and until Britain became part of the European Economic Community, agricultural self-sufficiency was an important political goal; farmers were encouraged to convert grassland to arable land. Because of this, 97 percent of lowland grassland existing in England before the war has been lost to farming practices such as plowing, reseeding, and fertilization.

Lastly, unlike the U.S., land in England has historically been in private ownership so when valuable grassland is discovered, it has to be purchased or a cooperative management plan has to be developed in order to protect that area. In the U.S., most protected native grasslands are owned by state, federal, or local government while in England the National Trust is the biggest landowner. The National Trust is a private charity which is committed to preserving the natural and cultural history of England.

The most serious management problems on managed or owned grasslands differ somewhat between England and the U.S. Until recently, the naturally occurring rabbit population in England has been kept in check by density-dependent diseases. However, the rabbit population has developed immunity to the most serious of these diseases in the past few years, causing it to increase at an alarming rate and destroy a significant amount of valuable grassland. Generally, rabbits are not a serious problem in U.S. grasslands. In the U.S., the invasion of exotic herbaceous plants such as thistle and cheatgrass, is a serious threat to even well managed prairies. In England this is not a significant problem.

In both the United States and in England the protection of rare and endangered species is a serious management concern and both countries are significantly involved in this process. A difference in the approach to this management problem is the location and identification of rare and endangered species. Often in areas managed by the National Park Service the occurrence of an important species comes to light only secondarily in the course of unrelated surveys or analysis. In England the National Trust conducts an intensive survey of all of its landholdings every 12 years. The goal of this survey is to document what is present and to identify important species.

Visitor impact is a much more serious problem in England than it is in the U.S. England has over 60 million people in an area roughly the size of Oregon so the impact of factors like trail erosion and dog fouling is uniformly at a high level that is rarely seen in the U.S.

Invasion of grassland areas by encroaching woody scrub is a serious problem in parts of the U.S. and in England. This problem came about in the U.S. by the suppression of fire and the cessation of grazing by large herbivores. The source of the problem in England is a series of political changes over the last several hundred years that affected sheep grazing. Cheap cotton from England's colonies reduced the demand for wool. Most of the grassland was common land and was lost due to a series of enclosure acts, designed to convert grassland to more lucrative arable land in the 17th, 18th, and 19th centuries. This left a remnant patchwork array of grasslands that were not accessible or large enough to support sheep production. This disused grassland rapidly became overgrown with encroaching woody species.

The grassland management practices used in the U.S. and England are similar but with some exceptions. Hay cutting and scrub removal are examples of similar management practices, but even scrub removal has some different approaches. In the tallgrass prairie of the U.S., scrub encroachment is controlled by grazing, burning, and physical removal, but herbicides are rarely used. The NPS used of herbicides in all its management areas is allowed by special permission only, and then only when the problem is severe and no alternative is available; whereas the National Trust in England, among its other herbicide recommendations, suggests that wick-applied herbicides be used consistently with brush cutting.

Burning is used to control large tracts of encroaching heather, bracken, and gorse in English moorland grassland, but it is rarely suggested as a method of control for promoting native species and inhibiting exotics as it is in the American prairies. The obvious reason for this difference is that fire was never a natural phenomenon in English grassland while native U.S. prairie grasses evolved in a fire-frequent environment.

Grazing is the most valuable grassland management tool in England. This is because English grasslands have had at least 2,000 years of adaptation to sheep grazing. Herds of ancient breeds of sheep are now being established for the sole purpose of maintaining and restoring grassland vegetation composition.

Reseeding is not part of the English philosophy of grassland management. Genetically similar strains of native tall grass prairie plants are routinely planted to restore the natural species composition in National Park prairies of the U.S. The English believe that reseeding addresses the symptoms but not the problems of grassland restoration. They also feel that reseeding can forever upset the competitive and successional balance that grassland ecosystems require for stability and stress resistance.

Additional research in grassland management is a pressing need in both countries for most aspects of grassland management but three areas are of particular importance. In both countries there has been a large number of specific management programs on grassland, but the results of many of these individual case studies have not been published or collected into a single accessible source. If this source included case studies from both countries, it would be of tremendous value. A second area of urgent research need is increased autecological studies (studies of the response of individual plants to their environments and management schemes). The third area, being vigorously addressed by both countries, is the effect of global climate change on grasslands.

An interesting difference between grassland management in U.S. historic sites and in England is the development of management objectives. In the U.S. the objective usually centers around the reestablishment of pre-settlement vegetation. The U.S. has a well-documented idea of a stable natural vegetation that existed before the influence of European settlers. High density population and significant agricultural influence has been part of the English landscape for more than 3,000 years, so there is no pristine pre-agrarian natural landscape to use as a management objective goal. The English Natural Trust can only use preservation of what exists as a management goal. Survey and assessment for each site will determine what aspects of the natural and cultural environment are precious for that specific area. The management goal will then usually center around the conservation of those aspects in an integrated manner.

Falcons Carry Heavy Nomenclature

In commemoration of the 75th anniversary of the creation of the National Park Service, peregrine falcons released this summer at Isle Royale NP were named for the 12 past NPS Directors: Mather, Albright, Cammerer, Drury, Demarayh, Wirth, Hartzog, Walker, Everhardt, Whalen, Dickenson, and Mott.

Peregrine falcons are doing well in the Great Lakes Region, considering that the breeding population was completely eliminated in the 1960s. According to Dr. Pat Redig of the Raptor Center in St. Paul, MN, there are five nesting pairs in the Twin Cities this year and at least three pairs in northern Minnesota. Michigan's uipper peninsula also has three nesting pairs.

Galapagos Position

The Charles Darwin Foundation for the Galapagos Islands (CDF) is seeking a director for its international research, conservation and education center, the CDRS. They are seeking an M.S. or (preferably) a Ph.D. or equivalent in a field of natural sciences, natural resource management or similar, with at least four years practical experience, preferably in Latin America; bilingual English/Spanish; 25-55 years old; at a starting salary of $20,000 US with many benefits.

Deadline for applications is Oct. 15, 1991, but if the deadline is past and you are interested, you may phone or Fax Dr. David Challinor at the Smithsonian in Washington, DC; Tel: (202) 673-4705; Fax: 202-673-4607.

Western Rattlesnake Ecology At Natural Bridges NM, Utah

By Tim B. Graham

Western rattlesnake (*Crotalus viridis*) is common on the Colorado Plateau, but infrequently seen. At Natural Bridges National Monument, these rattlesnakes are encountered often in the residence/visitor center area (R/VC). While only one person has been bitten (dry bite) in the developed area, (the victim apparently was drunk and tried to pick up the snake), the abundance of snakes in the R/VC is perceived as a safety issue. Snakes in the Natural Bridges population are generally very docile, and rarely attack, even when provoked. A young girl stepped on one in the campground in 1991; the snake rattled and crawled away.

The population of rattlesnakes at Natural Bridges appears to be an intergrade between two subspecies of *C. viridis* – the midget faded rattlesnake (*C. v. concolor*), and the prairie rattlesnake (*C. v. viridis*). The venom of *C. v. concolor* is more toxic than other species of *C. v. viridis*, and treatment of bites by *C. v. concolor* is different than for other subspecies (J. Glenn, pers. comm.). Work is continuing to determine the implications of hybridization on management of snake bites in the area.

Explanations for the abundance of snakes in the R/VC are numerous. It was suggested that the residence area was built on a den site. The pseudo-riparian habitat and abundance of food in the housing area have created higher prey densities than native pinon-juniper habitat, perhaps attracting the large numbers of snakes. The possibility that the R/VC was built in the path of migration routes between summer and winter snake habitat also exists.

Prior to 1983, rattlesnakes found in the R/VC were trapped and taken 3 km outside the Monument for release. A monitoring program was begun in 1983 to assess snake numbers and movements in the R/VC.



***Rattlesnake captured at den site** April 1991. Bright white marks on back are paint marks used to indicate this individual already had been captured at the den in the past few days. The elongated dark blotch near the tail (actually a number of blotches fused together), can be used to identify this individual year after year. (Photo by Tim Graham)*

All snakes encountered there were captured, anesthetized, and marked. Many marking techniques were tried, including sewing colored sequins onto rattles, and painting rattles. The most effective marking technique was found to be a natural one. Snakes have unique blotch patterns on their backs, which allow identification of individuals. From 1984 to 1988, each snake was photocopied (yes, actually stretched out on a xerox machine) to record its blotch patterns. Beginning in 1989, Polaroid photos were taken instead.

In 1988, a radio-tracking study was initiated to document overwintering sites, and movements of *C. viridis* in the R/VC. The accumulated data of snake captures and recaptures since 1983 also were analyzed for patterns of recaptures, numbers of unique individuals, and timing of observations.

Based on capture data from 1983-1988, and the available radio-tracking data, we are beginning to understand the role played by the R/VC in this area's rattlesnake ecology. It was believed the large number of sightings were actually multiple sightings of a few snakes returning year after year. However, data on snake captures and recaptures from 1983 to 1990 do not support this idea. Most snakes are found in the R/VC in only one year; in fact, most individuals are seen only once (Fig. 1). Snakes appear to be moving through the R/VC, perhaps foraging for a few days, then moving on.

We have identified 80 snakes since 1983; 17 were seen only at den sites, 6 were young of a radio-tagged snake, and 9 are known dead (5 road kills, 4 radio-

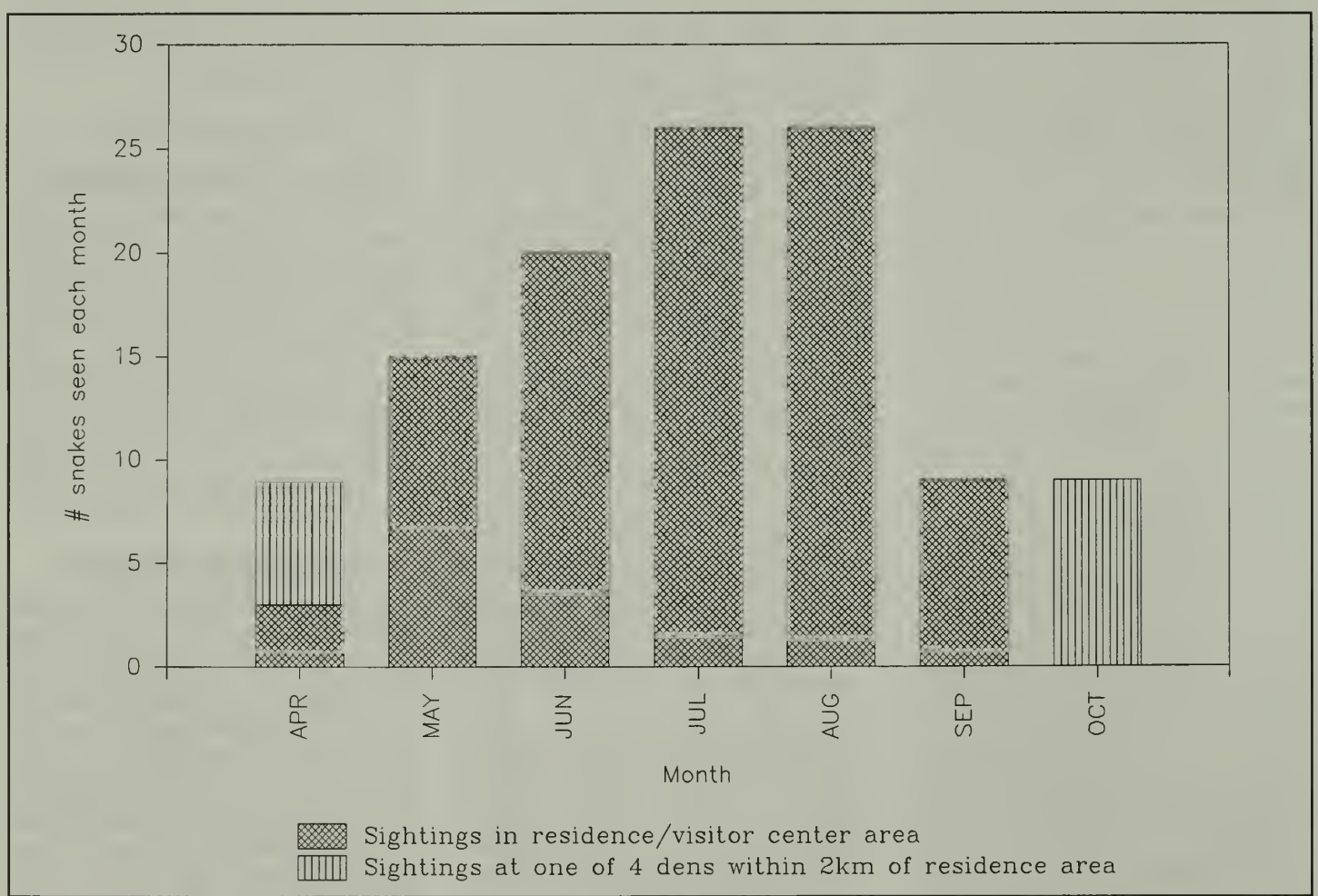


***Figure 2.** Numbers of snakes located each month, pooled over the years 1983-1990, in the residence/visitor center area and/or den sites.*

Rattlesnake Ecology

(Continued from page 10)

tagged snakes). Four overwintering sites have been located, and 17 snakes have been marked at den sites in 2 years. One of those snakes (#42) later showed up at the R/VC. In 1991, an additional 65 snakes were identified at two dens.

Small mammals were trapped in the R/VC in 1985 and 1988. Comparable trapping also was done in nearby pinon-juniper habitat. Results indicate that mice populations in the R/VC are much higher than in surrounding native habitat. However, radio-tracking has shown that at least radio-tagged snakes spend little time in the R/VC itself. Most radio-tagged snakes established home ranges outside the R.VC, though within 200-300 m of the developed area. Some movement into and out of the R/VC has occurred, but these movements are infrequent and do not appear to be consistently related to foraging. These data suggest snakes are not attracted to the R/VC because of its high prey densities.

The R/VC was built approximately halfway between two westward draining canyons. Den sites are in the upper reaches of these canyons in rocky ledges and outcrops. There probably are many sites suitable for overwintering along the south and southwest facing canyon walls. Movements of radio-tagged snakes indicate that snakes leave the dens and move onto the uplands between canyons to spend the summer. Frequent snake sightings in the R/VC are thought to be the result of proximity of the R/VC to two areas of quality den sites. Snakes disperse in all directions from both den areas. Snakes heading south from the north dens, and those going north from the south dens, move into/through the R/VC, increasing opportunities for encounters. A few snakes remain near the R/VC all summer, others pass through and don't return except perhaps



***Technician Trevor Persons** tracking rattlesnake with implanted radio transmitter at Natural Bridges National Monument. Snakes are located once or twice each day. Body temperature and a suite of microhabitat characteristics data are collected each time a snake is located. (Photo by Paul Menard)*

en route to their dens in autumn. Most snake sightings are in July and August (Fig. 2), which is consistent with snakes dispersing from their dens, eventually reaching the R/VC.

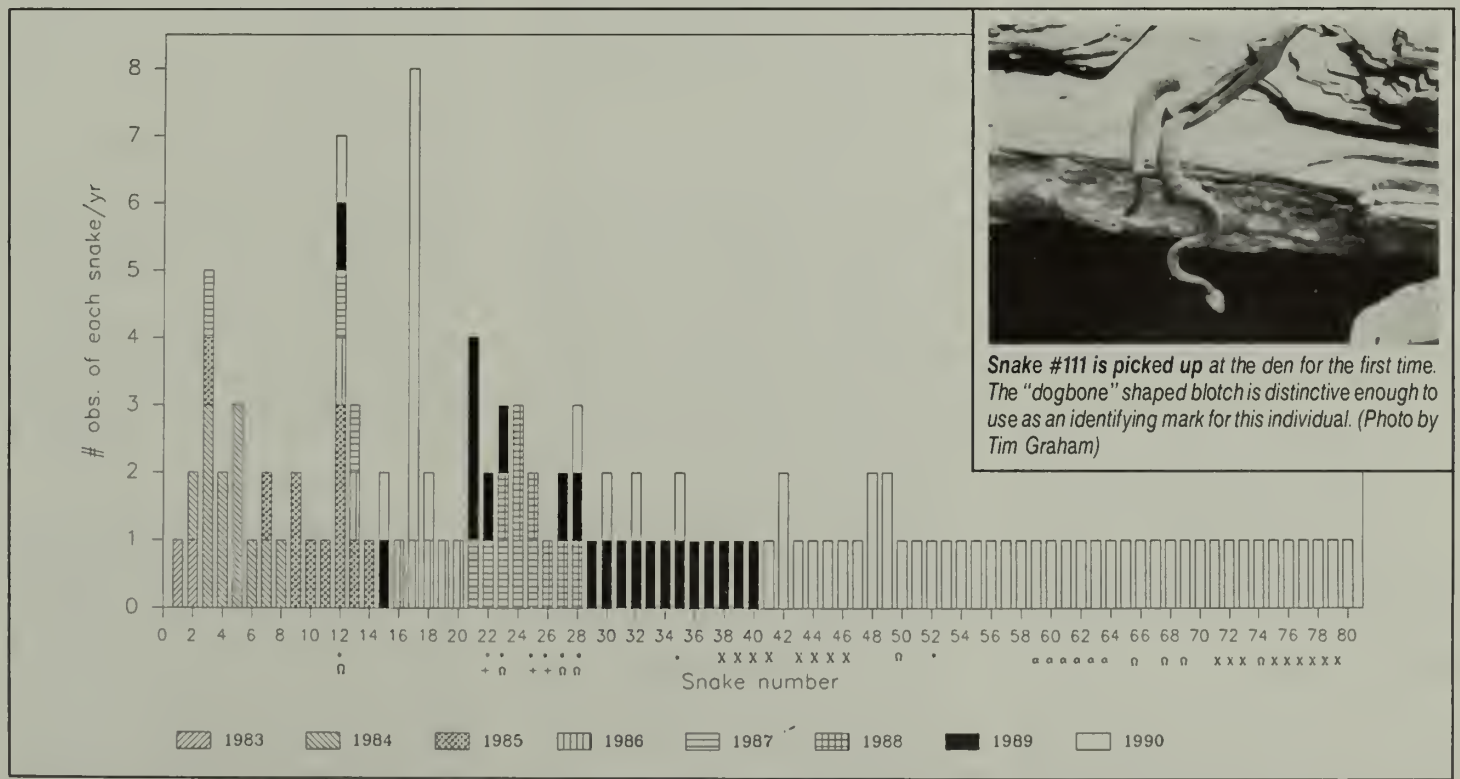
Crotalus viridis probably have been moving through the area now occupied by the R/VC at Natural Bridges for centuries. Changes in the area as a result of building and maintaining a residence area do not appear to have influenced snake movements or home range establishment significantly. There is no reason to expect that changes in the residence area character (e.g. removal of domestic landscaping, elimination of unnaturally high densities of small rodents) would affect the numbers of snake encounters in the R/VC. However, removing these characteristics of the R/VC habitat would provide a good test of the validity of the migration route theory.

Management options for dealing with the snakes are limited because of the nature of the problem. The R/VC could be fenced to exclude snakes. Certain parts of the R/VC have been fenced in the past – the community garden and a children's play area. These areas did remain snakeless most of the time, although occasionally snakes were found in the garden. Trying to exclude snakes from the entire area, while allowing access for vehicles, visitors, and residents, would be expensive, difficult, and most likely ineffective.

Snakes could be relocated if found in the R/VC area in an attempt to reduce interactions with people. This would have deleterious effects on the snake population, as relocated snakes would have difficulty finding their dens in the fall and probably would die for lack of adequate shelter. Given the densities of snakes at dens (over 60 individual snakes were identified at a single den in spring 1991), removing snakes from the R/VC may not solve the problem. Other snakes are likely to expand their home ranges into the R/VC area to occupy vacated home ranges.

Only one person having been bitten during 25 years of human occupation of the area, safety does not seem to be a significant issue at Natural Bridges NM. Given the non-aggressive character of *Crotalus viridis*, vigilance in the R/VC probably will prevent most encounters.

Graham is a Biologist at Canyonlands NP.



***Snake #111 is picked up** at the den for the first time. The "dogbone" shaped blotch is distinctive enough to use as an identifying mark for this individual. (Photo by Tim Graham)*

***Figure 1.** Capture data on 80 Crotalus viridis found in the Natural Bridges residence/visitor area, or near dens in the vicinity. Recaptures of the same snake in different years are shown in different patterns, and stacked. Snakes marked with * had radios implanted in 1988, 1989, and/or 1990. Snakes marked with Ω were either found dead (road kills), or died while carrying a radio, those marked with + had radios, but disappeared during the study. Snakes seen only at dens are indicated with X's, the offspring of #12 are marked with α.*

regional highlights

Wildlife and Vegetation Division

A new employee, Sharon Taylor, was welcomed aboard. Trained as a veterinarian, Taylor will be assisting in addressing the brucellosis issue.

* * *

Regional Chief Scientists Dan Huff (RMRO) and Ron Hiebert (MWRO) were in Washington at the Division in July, working on a strategic ecological research plan for national level research. The plan is being coordinated with the Ecological Society of America's plan to meet research needs in ecology.

North Atlantic Region

The Region will sponsor the Second Conference on Science and Resource Management in Northeast NPs Nov. 19-20, 1991 in Newport, RI. Further information can be had from Dr. Charles Roman, Director, NPS/CPSU, Coastal Research Center, U/RI, Narragansett, RI 02882-1197; 401/792-6886.

* * *

The NAR Office of Scientific Studies has been moved. We are not located at 50 Congress St., Suite 6, Boston, MA 02109.

* * *

Charisse Sydoriak, formerly the Fire Management office in the NAR, now is the Regional Resource Management Specialist.

Alaska Region

The Region recently entered into an interagency agreement with the USFWS to conduct a 3-year study on effects of jetboat use on salmon eggs, rainbow trout eggs, and fry survival in stream gravels. Field work will be conducted in Katmai and Lake Clark NPs. Both parks have heavy jetboat use and exceptional populations of spawning sockeye salmon and rainbow trout.

* * *

Paul McLaughlin, Resource Management Specialist in the Regional Office, participated in a USGS-funded international glaciological research expedition to Mount Bona (a 16,500 foot glaciated volcano in Wrangell-Saint Elias NP&P). The team collected snow, rock, and firn-gas samples for multiple research projects involving glacial dynamics, regional climatology, and volcanic geology. Future ice coring work at the site will expand scientific knowledge of paleoclimatoloty and regional volcanic history.

* * *

Recent published reports include:

Davis, J.L., L G. Adams, P. Valkenburg, and D.J. Reed. 1991. Relationships between body weight, early puberty, and reproductive histories in central Alaskan caribou. Fourth North American Caribou Workshop. Newfoundland and Labrador Dept. of Environment and Lands. St. Johns, Newfoundland, Canada. 115-140.

Western Region

Thomas J. Stohlgren is the author of a 220-page Technical Report (No. 43) from the CPSU at U/CA Davis, titled "Size distributions and spatial patterns of giant sequoia (*Sequoiadendron giganteum*) in Sequoia and Kings Canyon National Parks, California." Stohlgren's work stemmed from the lack of detailed information available in the size distributions, response to disturbance, spatial patterns, and role of intra-specific competition for the giant sequoia and aims at better directed future research on the underlying mechanisms causing the patterns observed on the landscape.

* * *

Three technical reports have been completed and two of them are sporting a new cover designed by CPSU/UA Editorial Asst. Gloria Maender. The cover photo was taken Oct. 4, 1935, in Saguaro National Monument, by the first NPS photographer, George Alexander Grant (1891-1964). The photo is from the George Grant collection, which resides in the Western Archeological and Conservation Center archives. Copies of these new reports may be had from the CPSU/UA in Tucson; (602) 670-6885.

1. Lowe, C.H. and P.A. Holm, "The Amphibians and Reptiles at Saguaro Nat'l Monument. Tech Rpt #37. CPSU/UA. Tucson, AZ. 20 pp.
2. Brian, N.J., "Resurvey of 1961 Line Intercept Transects at Tonto Nat'l Monument, AZ." Tech Rpt #38. CPSU/UA. Tucson, AZ. 67 pp.
3. Brown, B., "Land Use Trends Surrounding Organ Pipe Cactus Nat'l Monument (English version). Tech Rpt #39. CPSU/UA. Tucson, AZ. 65 pp.

Southeast Region

Joe Meiman and Marty Ryan have completed one year of water quality monitoring and one year of hydrology research on the north side of Mammoth Cave NP. Twenty-five successful dye traces have consistently demonstrated that north side water flows along the strike rather than the dip of the bedrock. This pattern is the opposite of what hydrologic research has shown on the south side of the river. According to George Gregory, "North side research is already rewriting the textbooks on the hydrogeology of Mammoth Cave." Researchers also have found an amphipod – a tiny shrimp-like animal, in pristine springs on the north side and are examining specimens in order to determine its taxonomic classification.

* * *

From Stephen Nodvin, leader of the NPS/CPSU at U/TN, comes word of the following developments:

1. The EPA has expressed interest in using the Noland Divide Watershed and related monitoring activities at Great Smoky Mountains NP as part of their program for long term monitoring of air pollution and acidic deposition effects. NDW is a candidate for a national network of 3 watersheds that would be used to monitor changes important relative to regulations introduced by the Clean Air Act Amendments of 1990. The proposed network would include sites from the northeast, midwest, and southeast-Southern Appalachians.
2. Ellen Williams, U/TN research assistant, participated in an environmental exchange program for 3 weeks in the Soviet Union. Other participants included Jason Houck and John Peine from Great Smoky Mountains and Dominic Dottavio from SERO.
3. Hope Barrett, an ecology graduate student, has been working with ERDAS software and Great Smoky Mountains GIS data to create models of susceptibility and vulnerability to gypsy moth infestation at Great Smoky Mountains NP.
4. Maria Leary, a Geography graduate student, has been working on completion of her Master's thesis on acid mine drainage at Big South Fork National River and Recreation Area.

* * *

Copies of "Scientific Studies in the Coastal and Estuarine Areas of Everglades National Park: An Annotated Bibliography" are available from South Florida Research Center, Everglades NP, PO Box 279, Homestead, FL 33030.

Midwest Region

The USFWS on July 22, 1991, classified a mussel, the winged mapleleaf freshwater mussel (*Quadrula fragosa*), as endangered. This species is similar in general appearance to the mapleleaf mussel (*Quadrula quadrula*), which is still widespread throughout the central U.S., but there are differences in the shape of the shells. The two species also can be distinguished by their habitat needs; while *Q. fragosa* seems to prefer clean riffle areas, *Q. quadrula* can exploit impoundments and a muddy substrate.

The winged mapleleaf historically occurred throughout the Mississippi, Ohio, Tennessee, and Cumberland River drainages, in at least 12 states. Approximately 99 percent of its habitat has been lost due to impoundments, channelization, pollution, and sedimentation resulting from soil erosion. The single known remaining population occurs along fewer than 5 miles of the St. Croix River within Saint Croix National Scenic Riverway on the Minnesota/Wisconsin border. This population's small size and restricted range makes it vulnerable to extinction from additional habitat degradation. Threats of a more indirect nature could include problems with the species of host fish (so far unknown) that the winged mapleleaf needs to parasitize during its larval stage.

An apparent lack of reproduction in the winged mapleleaf population is a concern. During surveys in 1988 and 1989, no gravid females were located, and no indivuals younger than 4 years could be found. Other mussel species in the same area did not show such reproductive failures.

Pacific Northwest Region

Jon Jarvis, who for the past 5 years has been Chief of Natural Resource Management at North Cascades National Park Complex in the state of Washington, has moved to the superintendency of Craters of the Moon National Monument in Idaho.

Another change at North Cascades is the acquisition of Reed Glesne as aquatic ecologist, replacing Bob Wasem who retired last year after 22 years with the Service. Glesne, who joined the park staff in July, came from the USFWS, where he had worked for 15 years.

* * *

The biggest skull known of *Rhinocerotidae Diceratherium armatum*, measuring almost 2 feet from nose to neck, has been discovered at John Day National Monument in Oregon. The rhino, who died nearly 25 million years ago, was covered by water-lain volcanic tuffs spewed from vents in Central Oregon or the early Cascades. He shared his tomb in the Oligocene tuffs of the Fossil Beds with oreodonts, early horses, giant pigs (Entelodonts), rodents, turtles, and a few fragments of Ekgmowechshala – a Lakota Sioux word meaning "cat that looks like a little man" – the last primate known in North America.

Ted Fremd, the monument's paleontologist, describes the finding of fossils like this as "part dili-

gence, part luck." The discovery of the rhino came on a fall day in 1989, when Ellen Stepleton – a graduate student working on other projects with Fremd, wasn on a cross country hike. The skull was so firmly embedded in surrounding rock that it was decided to let time help remove it. Preservatives and plaster were applied at once and again in 1990, and now the twice-postponed exhumation is about to occur.

Fremd says he hopes to learn an enormous amount from this skull – the largest ever found and complete, from nose to neck, including the rare "postcranial" area.

• • •

Boone Kauffman, fire ecologist with the Oregon State University Department of Rangeland Resources, is currently in Brazil on a fire ecology consultant mission, hence unable to fulfill his commitment to write a piece for ***Park Science*** on the role of fire in restoring natural ecosystems (promised on page 7 of ***Park Science***, summer 1991). He suggests instead a "Notes From Abroad" later on, describing his work in northeastern Brazil with tropical dry forests and the effects of fire on nutrients in the soil, forest, and atmosphere.

"It's the hottest, most miserable work anybody could possibly do," Kauffman told Carol Savonen for a story in OSU's ***Agricultural Progress*** (Winter 1990). "The temperatures in clearcuts get up to 112 to 115 degrees. And the insects are unbearable. You are constantly climbing through slash or areas that literally look like moonscapres – nothing but gray ash and charred trunks." Look for more on this in coming issues.

• • •

Entomologists at Oregon State University have identified an insect allatostatin – a neuropeptide that insects use to turn off their synthesis of juvenile hormone – critical to the growth and reproductive ability of an insect. This type of natural, non-toxic pesticide could be highly effective, specific only to harmful insects, and valuable in the ongoing struggle against pesticide resistance according to OSU Entomologist Grahame Pratt.

The work is a major advance toward development of a totally new type of insecticide. The neuropeptide is too easily degraded to work in a natural environment, Pratt said, but the findings may allow researchers to develop a more stable compound that mimics the biological action of the peptide.

If juvenile hormone is produced in too-low levels, the insect changes from a larva to an adult prematurely, reducing the time spent in its most destructive, plant-eating stage. It also becomes a sterile adult, causing insect populations to crash rapidly.

Rocky Mountain Region

Glen Canyon has issued permits for a research project on razorback sucker (*Xyrauchen texanus*) in Lake Powell and the Colorado River inflow area, and is considering a second proposal for similar work on the San Juan River and adjacent lake waters. The second project would concentrate on Colorado Squawfish (*Ptychocheilus lucius*), which have been found in the vicinity. The razorback is expected to be Federally listed as endangered in the near future and is considered one of the rarest Colorado river native fish. The squawfish already is listed as endangered.

The razorback study, led by the USFWS and Bureau of Reclamation, is a propagation and genetics investigation where fish are being collected for captive rearing and propagation under controlled conditions. The genetic makeup of the fish will be documented for comparison with closely related species. Park resource management staff participated in the study in April, assisting Utah biologists in collecting 2 adult razorbacks from upper Lake Powell. Both fish were healthy – in the 2 kg, 60 cm size range; one was a male in spawning condition, indicating some reproductive activities, even though recruitment has not been documented in the region in many years. Upon completion of the study, the original fish or an equal number of progeny will be returned to the areas where the collections were made.

The squawfish work would involve collection, measurement, tagging, and radio-monitoring by Bureau of Reclamation biologists in summer and fall of 1991. Both studies are part of interagency recovery efforts in the upper Colorado River basin. Glen Canyon has submitted a proposal to the Recovery Program for population and habitat research on both species.

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Several research projects were undertaken at Bryce Canyon this summer. Dr. Karl McKnight of St. Lawrence University began work on forest succession dynamics, building on an existing database developed over the past 30 years. U/SD botanist Dr. Frederick Peabody began a 3-year study of rare plant distribution and abundance and will develop a long term monitoring program for the park. Fire history research in the mixed conifer/aspen community type was conducted by Dr. Michael Jenkins of Utah State U, and Dr. John Hoogland of U/MD started a long term study of the ecology of threatened Utah prairie dogs.

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Badlands NP has implemented a research effort on prairie dogs related to the anticipated reintroduction of the black-footed ferret. Gillian Bowser, NPS employee currently enrolled in a Ph.D. program at U/MO-St. Louis, will use portions of the study for her dissertation.

Mid-Atlantic Region

Supt. Bill Wade and Resource Manager Dave Haskell of Shenandoah NP travelled to the Soviet Union as part of a Park Service/Soviet Union Exchange program. A group of Soviet park managers visited Shenandoah NP, Prince William Forest Park, and various NCR units in early August.

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Park Science Index Readied

In the next (Winter 1992) issue of ***Park Science***, an index of all four numbers for Vol. 11 will be published, listed by author, subject, and park. This same information is now available for all 10 of the previous volumes of ***Park Science*** and can be accommodated on any floppy disk. From now on, No. 1 of each new ***Park Science*** volume will contain an index of the previous four issues. Those wishing to have the index for the entire 10 previous years may have it by sending a floppy disk to Nancy Hori, Pacific Northwest Region Librarian, National Park Service, 83 S. King St., Seattle, WA 98104. Thank you, Nancy!

The Appalachian Mountain Club (AMC) and Regional Scientist Jeff Marion are nearing completion on "A Comprehensive Trail Inventory and Development Plan for Delaware Water Gap NRA." The project involved rapid trail surveys of all existing trails and woods roads in the park (for input into the park's GIS) and detailed prescriptive work logs of trail segments proposed for the new trail system.

Innovative procedures for developing the prescriptive work logs were perfected as part of the study. Pushing a trail measuring wheel, an experienced AMC worker dictated information regarding trail conditions, maintenance work needs, and suggested reroutes into a portable tape recorder. This information was transcribed to produce standardized trail work logs and summary tables that can be used to direct trail maintenance and estimate costs and personnel needs.

For copies of the report or information regarding the prescriptive work logs, contact Jeff Marion, NPS/CPSU, Virginia Tech Dept. of Forestry, Blacksburg, VA 24061-0324.

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Virginia Tech research foresters are conducting a vegetation inventory for 10 units of Richmond National Battlefield Park. Current vegetation types do not always reflect the conditions existing at the time of the civil war battles the park commemorates and seeks to portray for park visitors. Therefore, park managers want to restore and maintain historic vegetation patterns in selected areas. Historical research into regimental histories, personal letters, and photographs have revealed remarkably descriptive vegetative references from which historic vegetative maps are produced. Comparison with current vegetative conditions will allow the research foresters to recommend appropriate silvicultural strategies and actions for restoring and maintaining the historic vegetation types.

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John Karish announces availability of the following reports:

NPS/MAR/NRTR-91/049 - Identification, Restoration, and Maintenance of Historic Woodlots at Gettysburg National Military Park.

NPS/MAR/NRTR-91/050 - Floral Inventory and Vegetative Cover Type Mapping of Gettysburg National Military Park and Eisenhower National Historic Site.

NPS/MAR/NRTR-91/051 - Species of Special Concern, Exemplary Natural Communities and Wetlands within the Steamtown National Historic Site and Excursion Railroad.

NPS Visitor Report Published

A handsome, 30-page, slick paper report, illustrated with graphs and photos and titled *A Diversity of Visitors* has been published at the University of Idaho as an NPS Visitor Services project. Written by Margaret Littlejohn, an NPS employee duty-stationed at the U/ID NPS/CPSU, the booklet describes Visitor Services Project accomplishments over the last eight years and some insights about park visitors. The report makes delightful use of handwritten visitor comments, reproducing them as part of the illustrations.

Dr. Gary E. Machlis is Sociology Project leader and director of the Visitor Services Project team.

information crossfile

"Your Pond or Mine?" is the light-hearted title of a piece by Carol Ezzell in ***Science News*** (Vol. 140, p. 12), describing the mating habits of *Hyla chrysoscelis*, the gray tree frog, as they are detailed in a much-praised study by two Duke University population ecologists. The new research shows that males and females of this nonterritorial species have somewhat different criteria for what constitutes the ultimate love puddle, according to Ezzell.

William J. Resetarits Jr. and Henry M. Wilbur, the researchers, explained: "We're really interested not only in the behavior of individual species, but what effect their behavior may have on the community."

The research, published in the June ***Ecology***, reports on the results of 52 "long, sweaty summer nights" in the woods of North Carolina, monitoring the frogs' mating quirks at 45 "pseudo-ponds" (blue plastic wading pools painstakingly equipped to represent known types of breeding pools and laced with a wide variety of the varying life forms that make up different pond communities). Males proved interested only in finding mates; females were far more eager to finding the right pond conditions ... a fact that makes it appear the sexes are often "out of synch."

David McCauley, an ecologist at Vanderbilt University, commented: "I was quite surprised. The males were rarely at the right place at the right time, regardless of what was in the pond."

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Researchers at Oregon State University have again documented a massive die-off of toad eggs at a lake in the central Oregon Cascades. Together with unexplained amphibian declines and extinctions worldwide, this event has speeded efforts to understand the phenomenon. One possibility is rising levels of ultraviolet radiation. The National Science Foundation recently approved a three-year, $272,000 grant to OSU scientists to explore the amphibian declines. Zoologists Andrew Blaustein and Frank Moore and agricultural chemist John Hays are the principal investigators.

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T. Destry Jarvis, publisher, and Joan Moody, editor of the newly organized ***Earth Work***, published monthly by the Student Conservation Assn., promise in their August 1991 editorial that the September issue will "examine whether the conservation field is prepared for the year 2000, when two-thirds of the entering workforce will be women and minorities."

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Susan Power Bratton, research ecologist and head of the NPS/CPSU at U/GA, is leaving the NPS for an academic career in Pennsylvania. She is represented in the Summer 1991 issue of ***Orion*** with an article titled "Sleeping with Lions: The Wild and the Holy," in which she examines the evidence for early Christian monks living with or befriending the wild. *Orion* is the quarterly publication of The Myrin Institute of 136 East 64th St., New York, NY 10021, in association with Conservation International.

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The Fire Research Institute, PO Box 241, Roslyn, WA 98941-0241, announces three publications:

International Journal of Wildland Fire, devoted solely to issues in wildland fire, is now accepting manuscripts dealing with wildland fire science, management, or technology. Chief Editor, Canadian ecologist Ross Wein and his international editorial board ask that manuscripts be submitted to the Roslyn address.

The International Directory of Wildland Fire is a complete listing of managers, academics, organizations, vendors and consultants, education institutions, libraries, granting agencies, journals and newsletters involved in research, management, or publishing concerning wildland fire. The directory is updated annually, and is available in paperback and also on disk.

The International Bibliography of Wildland Fire contains more than 40,000 references to publications concerning all areas of wildland fire – science, management, and technology. Updated annually and available in both print and disk. For information, write the Institute in Roslyn.

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Kathy Dimont, editor the annual report of the Glacier NP and U/MT Cooperative Park Studies Unit, announces availability of ***Science in Glacier NP 1990***. Asst. Supt. Richard Peterson discusses "Research as a Management Tool;" Chief Scientist Clifford Martinka steps (figuratively) into the year 2072 and reports on "Our National Parks – A View from the Future;" and Dennis Murphy and Stuart Weiss take a look at Glacier's peculiar advantages for monitoring climatic effects on an ecosystem that is largely wilderness. The rest of the 58-page document covers visitor services, ecosystem studies, vegetation, wildlife, aquatics, and geology.

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Lawrence Baker, Alan Herlihy, Philip Kaufmann, and Joseph Eilers furnish a scholarly review in the May 24 ***Science*** (Vol. 252:1151-1154) of the National Surface Water Survey conducted by the EPA in acid-sensitive areas of the U.S. This statistically designed survey of lakes and streams found that atmospheric deposition was the dominant source of acid anions in 75 percent of the acidic lakes and 47 percent of acidic streams. Organic anions were dominant in one-fourth of the acidic lakes and streams; acidic mine drainage was the dominant acid source in 26 percent of the acidic streams. Other causes were relatively unimportant on a regional scale. Nearly all the deposition-dominated acidic systems were found in six well-delineated subpopulations that represent about one-fourth of the NSWS lake population and one-third of the NSWS stream population.

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An interdisciplinary group of climatologists, oceanographers, meteorologists, marine biologists, ecologists and other reef experts have found greenhouse warming unlikely to be the culprit in the coral reef bleaching currently attracting worldwide attention. At their National Science Foundation-funded June meeting in Miami, the experts found that "something is clearly amiss on the world's reefs," according to Leslie Roberts in the July 19, 1991 issue of ***Science***. But the group concluded dthat the biggest threat to reef health worldwide is "the cumulative effect of local perturbations" from population growth, land use, and resource exploitation. Christopher D'Elia, director of the U/MD Sea Grant College, said: "We are quick to worry about climate change but not so quick to worry about local effects."

The group recommended to the meeting's sponsoring agencies – NSF, NOAA, and the EPA – an international program of intensive, long-term monitoring throughout the world to collect data on all the physical and biological factors that affect reef health.

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Readers interested in endangered species in general and those that occur in national parks in particular may want to look up the March 8, 1991 issue of ***Science*** for articles by Chuck Fergus ("The Florida Panther Verges on Extinction") and by Stephen O'Brien and Ernst Mayr ("Bureaucratic Mischief: Recognizing Endangered Species and Subspecies"), and the July 19 issue for provocative letters commenting on these articles and answers by the authors.

The implications for those trying to protect and perpetuate threatened or endangered species, and for those who must decide what shall be protected, would appear to be confused, complex, and profound. What are the operational definitions of "species," "subspecies," and "populations" as they relate to protection afforded by the Endangered Species Act of 1973? In the case of the Florida panther, does the discovery that two very distinct genetic stocks are represented in the surviving animals mean that they are now unprotected, due to the Interior Department's "Hybrid Policy"? And how might the unresolved dilemma be exploited by development interests targeting panther habitat?

The gray wolf (*Canis lupus*) and the red wolf (*Canis rufus*) are similar cases in point. Is the red wolf today a hybrid between gray wolf subspecies and coyotes, and thus imperiled by strict enforcement of the Hybrid Policy? Already that policy has prompted a formal petition from the Farm Bureaus of Wyoming, Montana, and Idaho to remove the gray wolf from the Endangered and Threatened List. Similar logic has been used to prevent reintroduction of gray wolves into Yellowstone NP.

In the July 19 Letters column, some high-powered experts from various backgrounds go at the problems being raised – whether species should be defined on the basis of process or pattern, whether molecular data always provide final answers, how increasing knowledge of the natural occurrence of hybridization should affect management policy –. Although none of the questions raised are laid to rest, and only more questions are suggested, a reading of these two issues will deepen (and darken) the maze out of which operational decisions will emerge.

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Jill Baron and Sarah Spaulding of the NPS Water Resources Lab in Fort Collins, C), are co-authors with Diane McKnight, Richard Smith and J. Platt Bradbury of the USGS of an article titled "Phytoplankton Dynamics in Three Rocky Mountain Lakes, Colorado, U.S.A." that appeared in ***Arctic and Alpine Research***, Vol. 22, No. 3, 1990, 264-274. Three periods were evident: a spring bloom during snowmelt of the planktonic diatom *Asterionella formosa*, a midsummer period of minimal algal abundance, and a fall bloom of the blue-green alga *Oscillatoria limnetica*. Rapid growth of *A. formosa* during spring was followed by decline after snowmelt and may be related to grazing by developing zooplankton populations.

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In a 10-author article titled "Effects of Climatic Warming on Lakes of the Central Boreal Forest" in the Nov.

information crossfile

16, 1990 issue of *Science*, 20 years of climatic, hydrologic, and ecological records for the Experimental Lakes Area of northwestern Ontario are used to show that air and lake temperatures have increased by 2 degrees C and the length of the ice-free season has increased by 3 weeks. Also, higher than normal evaporation and lower than average precipitation have decreased rates of water renewal in lakes. Concentrations of most chemicals have incrased in both lakes and streams due to decreased water renewal and forest fires in the catchments. Thermoclines deepened and summer habitats for cold stenothermic organisms like lake trout and opposum shrimp decreased. Said the authors:

"Our observations may provide a preview of the effects of increased greenhouse warming on boreal lakes." Lead author is D.W. Schindler.

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A January 1991 *BioScience* article, "Shrimp Stocking, Salmon Collapse, and Eagle Displacement," by Craig Spencer, B. Riley McClelland, and Jack Stanford, describes the altered interactions in the food web of a large aquatic ecosystem (the Flathead River-Lake) caused by introduction of the opossum shrimp (*Mysis relicta*). Owing to predation by the shrimp, the authors say, "copepod and cladoceran zooplankton populations declined dramatically, contributing to the collapse of an important planktivorous fish population. Loss of this formerly abundant forage fish caused displacement of birds and mammals that had fed on them in an upstream tributary within Glacier NP."

The cascading negative effects from such introductions include, in this case, "the diminished number of human visitors to Glacier NP in autumn" due to the collapse of the kokanee spawning run, which once brought 100 eagles at a time to the visitor viewing area. Viewing area human visitors, who numbered 46,500 in 1983, were fewer than 1000 in 1989.

GWS 1992 Conference Theme: "Partners In Stewardship"

The George Wright Society (GWS)'s 1992 Conference on Research and Resource Management in Natural and Cultural Parks and Reserves is slated to be held in November in Jacksonville, FL, around the theme of "Partners in Stewardship." Co-chairpersons are John Donahue for the natural resource program and Harry Butowsky for the cultural side of the program.

Goals for the 1992 conference include increased participation by cultural resource experts, by other federal, state, provincial, and local agencies, and by non-governmental organizations. The planning committee and board members are soliciting opinions and suggestions and will welcome all input. Donahue can be reached at FTS 268-4274 and (202) 268-4274 Butowsky at FTS 343-8155 or (202) 343-8155. They may also be reached at USDI, NPS MIB, PO Box 37127, Washington, DC 20013.

GIS Users Conference At Denver in November

The Second National Park Service GIS Users Conference will bring together for the first time in more than three years all NPS users of geographic data technology to discuss their respective interests, achievements, applications and concerns.

On Nov. 18-22, 1991, this official NPS training opportunity will offer up to 12 workshops (depending on sign-ups), at a cost of 0 to $50, depending on the workshop. Potential workshops will cover hardware, software, Global Positioning System, image processing, photointerpretation and data transfer, map preparation for digitizing, text database, position descriptions and classification, electric power, networking, data documentation and quality control/quality assurance, and data distribution and the Freedom of Information Act.

Conference location is the Sheraton Hotel at Lakewood, CO; Leslie Manfull of the GIS Division is conference coordinator, (303) 969-2590; FTS 327-2590.

Director's Achievement Awards Go to Van Riper, Taylor, Rambur

Charles van Riper III, Dan Taylor, and Richard Rambur were named in August as the 1991 winners of the NPS Director's Annual Achievement awards for research, natural resource management and superintendency, respectively.

Van Riper, currently leader of the newly established CPSU at Northern Arizona University (see p. 6), was cited for being "instrumental in breaking down state and regional barriers by promoting the first ecosystem-based CPSU. His high caliber research encompasses ornithology, conservation biology, and wildlife management," for having more than 50 peer reviewed publications, and for assisting in important resource management projects such as removal of feral pigs to reduce disease impacts on native Hawaiian birds and improved traffic contol techniques to protect endangered Great Grey Owls in Yosemite NP. He also was commended for "ability to synthesize research results into easily understood procedures that NPS management personnel can put to practical use."

Taylor, Chief of Resource Management at Hawaii Volcanoes NP, has been a leader in his park and in the region in addressing "an impressive array of resource problems, including management of feral pigs and goats, exotic plant control, protection of lava tube caves, and monitoring of aircraft overflights." His innovative approaches to problems have served as a model for other parks throughout the Service. The Western Region recognized him for his abilities in working with industry and agency representatives to solve problem threats and for "his optimism in the face of tremendous natural resource problems in Hawaii."

The first ever NPS Director's award for Natural Resource Stewardship by a Superintendent followed on the heels of such an award last year by the NPS Western Region. This year's recipient, Rambur, is in charge of Antietam National Battlefield, where he "completely redefined" the park's resource management objectives and began their aggressive implementation. He laid the groundwork for restoration of the woodlands and the historic agricultural scene, to preserve landscape and increase wildlife habitat. He is using a GIS to address external issues and to aid historic scene restoration, and has taken steps to modify or curtail in-park activities adversely affecting natural resources.

meetings of interest

1991

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL - JOINING HANDS FOR QUALITY TOURISM, in Honolulu. For registration and travel/housing information: Ray Tabata, UH Sea Grant, 1000 Pope Rd,., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2825.

Nov. 4-7, MEETING THE BIODIVERSITY CHALLENGE a short course for decision-makers, sponsored by BLM, USFWS, USFS, and NPS, at Phoenix Training Center, AZ. Contact: John Dennis, (202) 243-8128.

Nov. 16, NEZ PERCE ART EXHIBITION opens at the Nez Perce National Historical Park, Spalding, ID. To run through Jan. 12, 1991. Contact: Nez Perce NHP, PO Box 93, Spalding, ID 83511; (208) 843-2261.

Nov. 19-20, SECOND CONFERENCE ON SCIENCE AND RESOURCE MANAGEMENT IN NORTHEAST NATIONAL PARKS, in Newport, RI. Contact: Dr. Charles Roman, NPS/CPSU, Coastal Research Center, U/RI, Narragansett, RI 02882-1197; (401) 792-6886.

1992

Jan. 21-23, FIRE IN PACIFIC NORTHWEST ECOSYSTEMS: EXPLORING EMERGING ISSUES, at Red Lion Hotel, Portland, OR, featuring 40 regional and national experts on various aspects of wildfire presenting state-of-the-art information on historical and ecological aspects of fire and its use to achieve management objectives. Contact Conference Assistant, College of Forestry, Oregon State U, Corvallis, OR 97331; (503) 737-2329.

Feb. 10-21, FOURTH WORLD PARKS CONGRESS, in Caracas, Venezuela; a technical, invitational, working meeting of leading world authorities on protected area management, sponsored by the IUCN and co-sponsored by UN agencies, governments, and national agencies including the NPS.

Feb. 19-22, SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme: "Social Aspects of the Wildland/Urban Interface," at the Clarion Hotel, Ontario, CA. Contact: Debbie Chavez, USDA Forest Service, 4955 Canyon Crest Dr., Riverside, CA 92507.

May 17-20, FOURTH NORTH AMERICAN SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, in Madison, WI. Contact: Donald R. Field, 1450 Linden Dr., Madison, WI 53706.

National Park Biotic Inventories Assessed

By Thomas Stohlgren, Michael Ruggiero, James Quinn and Gary Waggoner

As part of the National Park Service's Inventory and Monitoring (I&M) Program, we are reporting results from a recently completed survey of biotic inventories in Western Region parks and preliminary results from a similar nation-wide survey of 240 national park units (175 reporting in so far).

In the completed Western Region Survey, Stohlgren and Quinn (CPSU Technical Report No.44, UC Davis, 1991) evaluated existing natural resource data from 40 national parks and monuments in Arizona, California, Hawaii, Nevada, and several Pacific Trust Territories. The primary objectives of this survey and the nation-wide survey were to: (1) provide a qualitative assessment (categorical summary) of the status of species lists for various biological groups (vascular plants, mammals, birds, reptiles, amphibians, terrestrial and aquatic invertebrates, and non-vascular plants); (2) inventory mapped information on vegetation, soils, geology and other natural resources; and (3) inventory photographic series, aerial and satellite imagery, and digitally processed information.

Methods

Western Region Survey

Species occurrence records were broken up by taxonomic group. Each group was scored by the park experts for completeness on a scale of 1 to 7 in each of three categories – geographical completeness, ecological completeness, and taxonomic completeness (Biological Inventory Status (BIS) scores; Table 1).

Geographic completeness refers to the percentage of the entire park included by previous inventories. Ecological completeness refers to the percentage of the total number ecological communities previously sampled. Taxonomic completeness refers to the probable percentage of extant species currently listed. These were summed to give an overall idea of completeness ranging from 3 (extensive knowledge) to 18 to 19 (essentially nothing known).

Also, the number of new (or recently discovered) species over the past 10 years was recorded. Information on maps (thematic and cartographic) and imagery (aerial photographs and digital satellite images) was catalogued (additional details on methods are given in Stohlgren and Quinn 1990).

Nation-wide Survey

In the nation-wide survey, the same data were recorded for the major biological groups, although most regions did not address invertebrates or non-vascular plants. The amount of time spent in the national park unit varied.

For the nation-wide and Western Region surveys, the data were self reported by park staffs and reflect the state of their knowledge. Results have not yet been verified. Thus, data that exist but were unknown to the park staff are not reported. We have discovered several cases of important park inventory records (e.g., geologic maps, published species lists) whose existence was not known to the current resource specialist in the park.In some cases, this may lead to an underestimate of the quality of inventory information. On the other hand, it is also is likely that "completeness" in many cases was substantially overestimated (see Stohlgren and Quinn 1990).

Table 1. *Biological Inventory Status Codes*

Individual Scores for Taxonomic, Geographic, and Ecological Completeness:

1 = Inventory probably >95% complete
2 = Inventory 80% to 95% complete.
3 = Inventory 50% to 80% complete.
4 = Inventory <50% complete.
5 = Inventory contains good information about a few taxa, in a local area or in a few communities.
6 = Inventory poor to nonexistent.
7 = Taxonomic completeness unknown.

Composite Score (Taxonomic + Geographic + Ecological Completeness):

3 = Inventory probably >95% complete.
4-6 = Inventory 80% to 95% complete.
7-9 = Inventory 50% to 80% complete.
10-13 = Inventory <50% complete.
14-17 = Inventory contains good information about a few taxa, in a local area or in a few communities.
18-19 = Inventory poor to nonexistent or unknown.

Table 2. *Preliminary results from Biological Inventory Status from the nationwide survey. A mean composite score >6 of taxonomic, geographical, and ecological completeness suggested species lists were <80% complete.*

Biological Group	No. Parks Reporting	No. Parks With Lists <80% Complete	% Parks With Lists <80% Complete
Vascular Plants	175	113	64.6%
Mammals	172	140	81.4%
Birds	172	121	70.3%
Fishes	153	123	80.9%
Reptiles	173	147	85.0%
Amphibians	168	142	84.5%

Results and Discussion

Western Region Survey

Fewer than 10 parks in Western Region reported that their species inventories were "probably complete" (i.e., thought to be at least 95% complete) taxonomically, geographically and ecologically (composite score of 3; Fig. 1). The vast majority (>73%) of the lists are thought to be less than 80% complete in their taxonomic, geographic and ecological (community type) coverage. Most Western Region parks knew more about vascular plants and birds than about other groups, but many parks had high composite scores for even the best known groups (Fig. 1). About half the parks reported essentially no research on invertebrates or non-vascular plants: major components of biological diversity. Very few parks have attempted systematic surveys (studies by specialists on the group in question according to a sample protocol from which relative completeness can be judged) for any of the biological groups.

Staffs of large parks tend to know more about their natural resources than those of smaller parks that historically have received less funding for research and resource management activities, although an extensive I&M program in small parks may produce much of the total biological diversity of the park system.

In the past 10 years, 1439 vascular plant species, 111 bird species and 15 mammalian species have been added to parks' species lists. 859 new species terrestrial invertebrate were added to seven park species lists. These data illustrate the incompleteness of current species lists.

While 85%, 52.5% and 65% of the 40 parks surveyed had maps of vegetation, soils and geology, respectively, none of these maps have been checked systematically for accuracy. There has been little standardization of classification schemes among parks.

Nation-wide Survey: Preliminary Results

Preliminary results from 175 park units from 8 regions (including Western Region) show striking similarities to the Western Region survey results (Table 2). Again, the vast majority (>77%) of the lists are thought to be less than 80% complete in their taxonomic, geographic and ecological coverage.Likewise, information on vascular plants and birds is generally better than that for the other biological groups.

In the Western Region and nation-wide surveys, the actual status of information is difficult to assess due to a lack of catalogued and readily accessible information on past studies of resources, essentially no standardization in recording procedures, missing or poorly maintained voucher specimens, and disproportionate attention to "popular" taxa.

Stohlgren and Quinn (1991) suggest minimum inventory needs for most biological groups in most parks include: (1) systematic, standardized surveys in each park; (2) increased collection and improved curating of voucher specimens (e.g., using the Automated National Catalog System); (3) expert checking of problematic specimens for proper identification; (4) in-park personal computer-based, standardized and compatible software for easy data entry, editing, and reporting and for ease of use and for interagency exchange of information; (5) a central "clearing house" for handling taxonomic synonyms, duplicate voucher specimens and data exchange; and (6) development of standard-

Biotic Inventories *(Cont'd)*

ized field techniques to assess the "completeness" of species lists.

We are continuing to create FLORA and FAUNA databases that contain species listings and associated data for each park based on documented occurrences of plant and animal species in parks. We have completed these listings for more than 60 parks and expect to complete all of the parks this year. Two other related data bases are being created.

We now are working to complete the Phase I survey of BIS data for the 240 parks with significant natural resources. We are beginning to develop alternative strategies for a long-term, service-wide I&M Program (NPS-75; Stohlgren and Quinn 1991). We will identify those servicewide biotic resources which are least well known, based on the Phase I I&M results. We will suggest "minimum standards" for natural resource inventories in national parks areas. A conceptual framework for evaluating the accuracy and completeness of available species lists will be developed. We will begin to review the available literature on appropriate theoretical, conceptual and mathematical models to evaluate completeness. We also will evaluate new developments in sampling design strategies for inventory and monitoring biotic resources.

By October 1992, we plan to produce the following: (1) a system-wide assessment of the completeness of biological inventories of vascular flora and vertebrate fauna, (2) an inventory of "candidate" flora and fauna of the National Park System in both printed and data base format, specific for individual parks and aggregated for regional and national levels, (3) a "user-friendly", PC-based computer program and associated data base for each park that can be consolidated at the regional and national levels, (4) a system-wide analysis of the biological similarity among parks based upon flora and fauna information, and (5) a strategy for acquiring and managing new flora and fauna data as we proceed toward our goal in the year 2000.

Stohlgren is a Research Scientist with the NPS/CPSU at U/CA/Davis; Ruggiero is Chief of the NPS Wildlife and Vegetation Division in Washington, DC; Quinn is with the U/CA/Davis Divison of Environmental Studies; Waggoner is with the NPS/GIS Division at the Denver Service Center.

Haleakala Rabbits Declared Eradicated (For Now)

As of May 1991, the rabbit outbreak at Haleakala NP (see ***Park Science*** 11(1):21) is believed to be under control. A total of 97 rabbits were removed between August 1990 and March 1991, primarily by snaring. The population is believed to have originated in October 1989 with the release of six pet rabbits. It was discovered in July 1990, at which time it occupied 60 acres. I would state the lessons learned from this experience as follows:

1. There is an abundance of pet rabbits on the island of Maui. Many pet owners are irresponsible (and break the law), based on the dozens of reported instances of loose rabbits during the past year. Much potential exists for recurring outbreaks of rabbits on Maui unless preventive steps are taken.

2. Rabbits usually occupy small home ranges and are very likely to escape detection in the early stages of population buildup.

3. Haleakala NP has apparently succeeded in eradicating this rabbit infestation. Factors contributing to this success included: (a) an unambiguous mandate from the park superintendent, a strong commitment by many individuals, and exceptional cooperation among park personnel to prevent permanent establishment of rabbits; (b) availability of personnel experienced in snaring and other feral animal control and monitoring techniques; (c) a group of domestic rabbits that were, at least initially, more naive and vulnerable to a control program than their wild counterparts (evidenced by lack of diurnal tendencies and significant burrowing); (d) the flexibility of the park to act promptly with considerable attention to detail (high density of snaring network, rigorous monitoring, careful media relations) and to expedite environmental impact assessments.

4. Snaring was the most effective control method, largely because the rabbits followed discrete (also discreet) paths amongst the dense shrub/grass vegetation. Snaring became much less efficient as rabbit density became sparse and individual rabbits became snare shy. If snaring had not worked there were no other obviously good options for control.

Lloyd Loope, Research Scientist, *Haleakala NP*

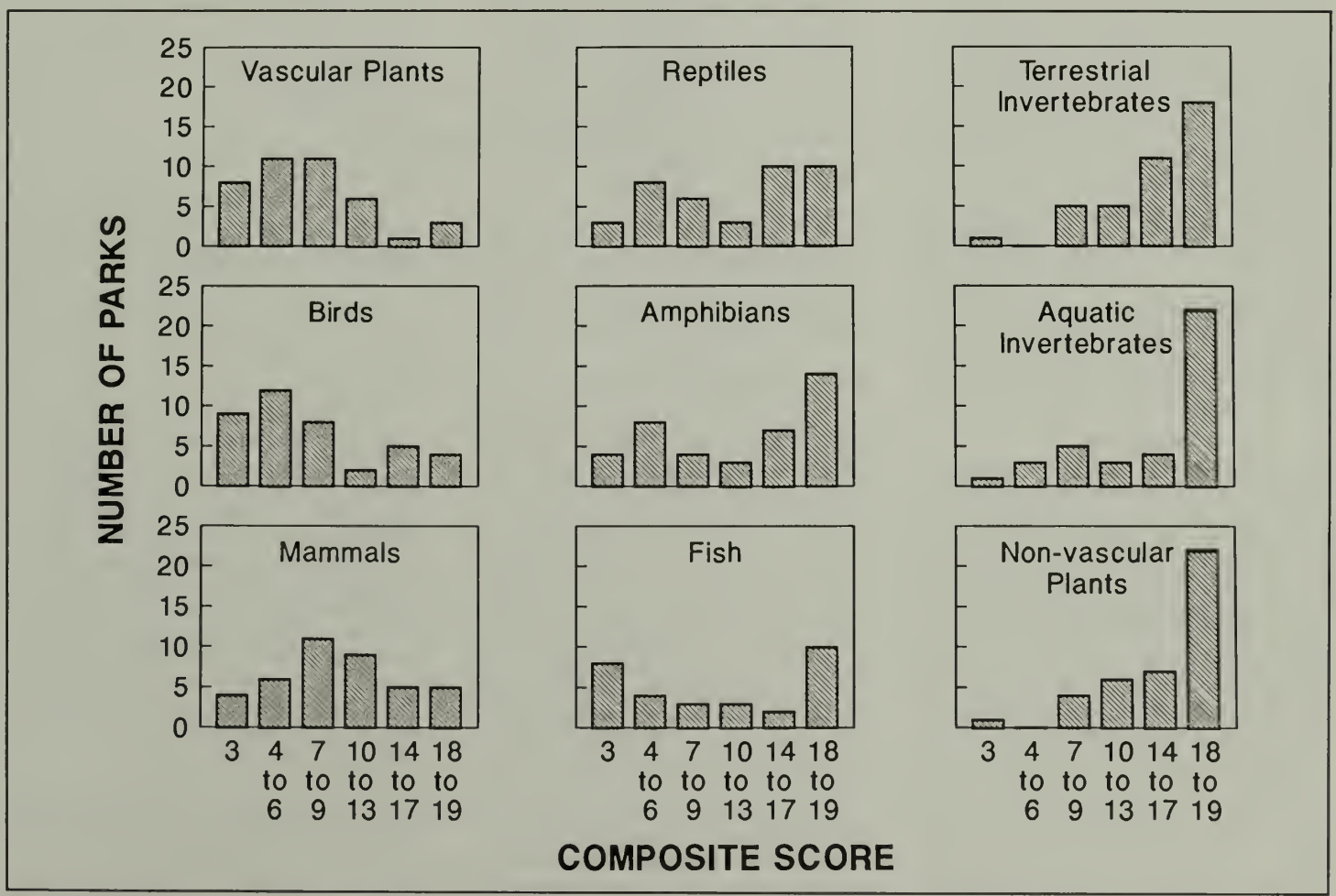


Figure 1. *Composite scores (taxonomic + geographical + ecological completeness) for vascular plants, mammals, birds, reptiles, amphibians, fish, terrestrial and aquatic invertebrates, and non-vascular plants in Western Region park areas.*

Mexican Spotted Owls in Zion NP: Inventory and Monitoring Methods

By Sarah E. Rinkevich

The recent listing of the Northern spotted owl (*Strix occidentalis caurina*) by the USFWS as a threatened species (Federal Register 1990) continues the debate over the long term survival of this species (Thomas et al. 1990). Following on the heels of this controversy, the Mexican spotted owl (*S. o. lucida*) currently is under consideration for federal listing as threatened or endangered (Wilcove 1987, Smith 1990). This subspecies already is listed as threatened by Arizona (Arizona Game and Fish Commission 1988).

While much is known about the Northern subspecies and the California subspecies (*S. o. occidentalis*), little information is available on home range, winter habitat use, or demography of the Mexican spotted owls of the southwestern United States. In addition, very little is known of the status and ecology of spotted owls in canyonland habitat such as Zion NP. It is crucial that Mexican spotted owl distribution and abundance be assessed in areas that are isolated (extinction prone) and receive heavy human use.

Early studies of spotted owls in Zion (Kertell 1976, Murphy 1988) reported only a few owl locations widely distributed throughout the park. Owls appeared to be associated with narrow, steep walled canyons as well as "hanging canyons." The rugged terrain of Zion park was a major obstacle for biolgists conducting spotted owl surveys. According to Murphy (1988), the use of a parabolic dish proved instrumental in locating spotted owls in the park. Few published studies in the use of the parabolic microphone in avian studies exist in the literature. In 1989, Zion NP initiated a two year survey of Mexican spotted owls. During this study, Rinkevich and Gutierrez (1991) documented distribution and abundance of Mexican spotted owls in the park as well as the use of the parabolic dish.

This paper reports our methodology and protocol for surveying for owls using the parabolic dish used during the two year study. Our main objectives in this paper are to: (1) document our techniques of an inventory method using a parabolic dish for detection of Mexican spotted owls in Zion NP, (2) report on our results of the two year survey, and (3) make suggestions for using the parabolic dish as a tool for future Mexican spotted owl surveys in canyonland country such as Zion.

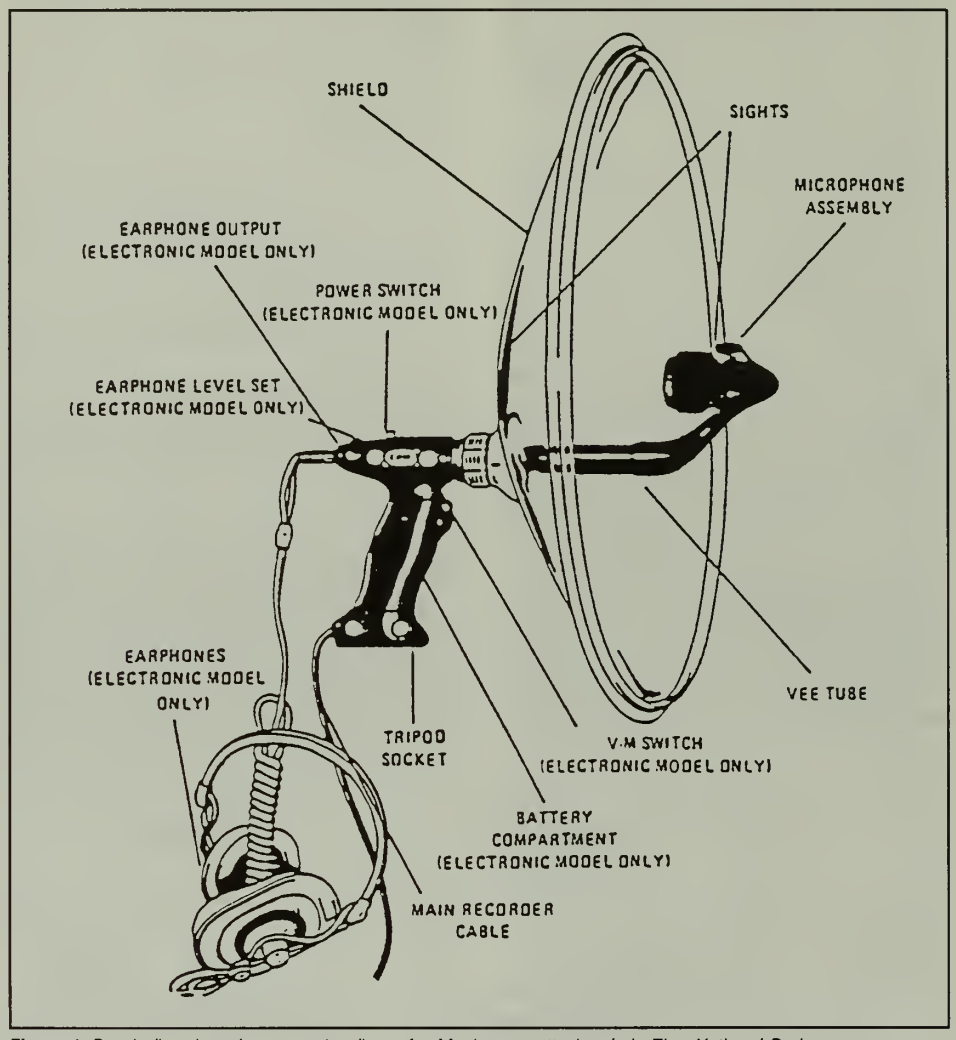


Figure 1. *Parabolic microphone used to listen for Mexican spotted owls in Zion National Park.*

Methodology

Owls were located by imitating their vocalizations during both day and night surveys (Forsman 1983, Freanklin et al. 1990) from May-August 1989 and April-August 1990. We used "point surveys" which were conducted by calling 10 minutes each hour at selected ridge and mesa-top vantage points within the park. We listened the remaining time, using a 45.7 cm diameter plastic parabolic dish and microphone (Fig. 1). These surveys were conducted for 3-5 hour periods between 2000 and 0500 hours (Mountain Standard Time). Once an owl(s) was heard, we attempted to locate the owl's roost site during a daytime walk-in survey.

Since many areas of Zion were canyon networks, the parabolic reflector was not oriented to any particular compass point. Instead, we pointed the microphone toward the direction of potentially suitable habitat as well as historical sightings of Mexican spotted owls. We recorded time and duration of the survey, temperature, wind speed, cloud cover, and other owl species detected. Sex of spotted owls was determined by their voices; females have a higher tonal pitch. Plateau regions within the park also were intensively surveyed.

Results and Discussion

Two hundred and nineteen surveys were conducted throughout canyons and plateau areas in Zion NP. Approximately 4200 working hours were spent conducting surveys during 1989 and 1990. Mexican spotted owls were uncommon but widely distributed in the park and appeared coincident with the patchy canyon habitat.

All spotted owls were found in deep, steep walled canyons in nine locations (Table 1). The crude density of owls in the park was 0.03 owls/km2, which is lower than the density of such birds in other western states. Bias and Gutierrez (1988) reported a density of 0.20 owls/km2 for a population of the California subspecies in the Sierra Nevada, California. Density estimates for two California spotted owl populations inhabiting habitat islands in southern California were 0.19 owls/km2 and 0.64 owls/km2 (Gutierrez and Pritchard 1990).

This density estimate provides an initial step in estimating owl abundance in the park and also represents the first comparison of density among populations of the three subspecies. Although Zion owls apparently occurred in a much lower density than other spotted owl populations, I do not know that this reflects poor habitat quality (Van Horne 1983); our results also could be due to low vocal response rates of owls, weather, or a sampling problem related to the park's inaccessible terrain.

Access to owl sites was the major limitation encountered. Surveying potential habitat was difficult due to the extremely rugged park terrain, which has few roads and trails. Relatively few avian studies have been conducted in areas with rugged terrain (Dawson 1981). In several instances, my method for surveying unaccessible areas (e.g. climbing neighboring mesa tops to gain a vantage point) proved successful in finding owls. In many instances, the parabolic was needed to confirm a response at these vantage points because of the great distance (>5 km) between observed owls. Moreover, 37 percent of detections I encountered were naturally (as opposed to elicited responses) calling owls, even though spontaneous calling by spotted owls is considered infrequent (Forsman 1983).

Although gusts of wind and nose from stream flow posed some problems, the parabolic dish greatly improved the chances of hearing an owl, expecially given the variety of topographic conditions in Zion park.

Hanging canyons appeared to be an important habitat type for Mexican spotted owls in Zion. Fifty-six

percent of owls I detected were located in hanging canyons. The remaining 44 percent were in canyons with inaccessible cliff sites. The rate of erosion of these hanging canyons lags behind that of the main canyon, resulting in a smaller watershed. Because these hanging canyons are generally inaccessible to biologists, the parabolic dish was necessary for surveying this type of habitat. I attempted to survey all hanging canyons that I could traverse or survey from a vantage point. I am unable to speculate on the total number of suitable hanging canyons within the park and I believe there is more potentially suitable owl habitat left unsurveyed because of inaccessibility.

Recommendations

The use of the parabolic reflector combine with calling surveys proved a useful tool in Zion's rugged canyon country for detecting Mexican spotted owls. The dish should not be used when wind gusts exceed 20 mph. Areas with potentially suitable habitat should be revisited even if not response has been heard, since it often takes several visits to elicit a response (Franklin 1986).

Although parabolic reflectors are not useful for locating roosting owls during daytime searches, it provided information on distribution and density estimates that is crucial for species management in Zion NP. The parabolic unit is light (about 3 lbs.) easily dissembled and portable through dense vegetation, and can be quickly reassembled when a vantage point is located. Current cost of the parabolic reflector unit begins at $600.

Knowledge of the biology of Mexican spotted owls in Zion is limited and changing rapidly. Long term monitoring plans and habitat studies have been initiated within Zion park, and the overall knowledge gained will benefit from similar studies in other parks as well. Montoring of known sites is crucial in determining population stability and productivity and will increase understanding of spotted owl biology. Studies focusing on owl prey base and juvenile dispersal also should be considered. In order that proper management criteria can be set, better understanding of the Mexican spotted owl throughout its range in the southwestern United States is needed.

Rinkevich is a seasonal wildlife biologist, working at Zion NP.

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Acknowledgments

I thank Larry Hays for reviews of this manuscript, and also R.J. Gutierrez (principal investigator) for his guidance and insightful ideas. Michael Alexander I thank for his contribution – athletic ability resulting in a pair of owls I probably would not have detected, and assistance. Doug Call and Kari Norgaard assisted in the 1989 inventory.

Table 1. Summary of canyon names, owl status and a brief description of the site used by Mexican spotted owls during 1989-1990, Zion National Park, Utah.

Canyon Name	Owl Status N=17	Description of Site
Echo Gorge[1]	1 pair, juveniles	Narrow gorge
Kolob Creek Canyon	1 pair	High-walled canyon
Lady Mt. Canyon[3]	1 pair	Hanging canyon
La Verkin Creek/Willis Creek[3]	1 male, status unknown	Steep-walls/cliff
Oak Creek Canyon[3]	1 pair	Hanging canyon w/cliff sites
Orderville Canyon[2]	1 pair	High-walled canyon
Pine Creek Canyon[1]	1 pair, juveniles	Narrow canyon w/smaller, hanging from canyons present
Refrigerator Canyon[1]	1 male, status unknown	Hanging canyon
Right Fork[2]	1 pair	Narrow canyon

[1]Access to owl site was moderately difficult requiring minimum rock climbing (class I, II) (Brereton and Dunaway 1988).
[2]Access to owl site was difficult and required intense rock climbing; a rope and harness was needed for belays and repel (class III-V) (Brereton and Dunaway 1988).
[3]Owl site was completely unaccessible.

mab notes

The FY 1991 grant awards made by the U.S. National MAB Committee include several of particular interest to the NPS.

- an interdisciplinary project by MAB's Human Dominated Ecosystems Directorate to develop coupled models of regional ecological and social systems. The models focus on improving managers' capability to assess and predict the implications of alternative ecosystem use and management policies, through case studies in the Pinelands, Virginia Coast, and Everglades Biosphere Reserves. The project involves specialists from six universities. Directorate member John Hadidian, urban ecologist in the National Capital Region, is participating in regional modeling relating to threatened and endangered species.
- an international workshop for managers of high latitude BRs, proposed by Dale Taylor of the Alaska Regional Office, to be held at Denali BR in September 1992. The workshop will focus on identifying resource issues and research goals, comparing management approaches, and developing recommendations for cooperation in the tundra biome.
- a comparative study in Jamaica and the U.S. Virgin Islands to look at ecological, social, and economic factors affecting mangrove ecosystems.

The National Committee called on the Coordinating Committee for Biosphere Reserves to submit its **draft plan for the U.S. biosphere reserve program** for review by October 1991. The plan will present the conceptual basis for establishing and organizing BRs in the U.S.: Centers for learning how to maintain biodiversity within regional and global change.

The **World Parks Congress** in February 1991 will include a workshop on development of BRs over the past 5 years, when establishment of new BRs provided for their intended functions much better than in earlier years. Bill Gregg, NPS MAB Coordinator, is scheduled to present a synthesis paper with Silvio Olivieri of Conservation International on "Biosphere Reserve Designations, New Organization and Holistic Problem Solving."

Napier Shelton
NPS Washington Office

In the Next Issue

"GIS at Colonial NHP: A New Approach" by Devine, Rafkind, and Karish; "Great Smoky Plants and Ozone Sensitivity" by Hacker and Renfro; "Shenandoah GIS Viewshed Analysis" by Teetor and Haskell; "Remedial Measures for Great Smokies Acidified Streams" by Kucken, Maas, and Patch; "GIS Program Started at U/AZ CPSU" by Potter, Kunzmann, and Guertin; "External Development Effects at Theodore Roosevelt NP" by Wallace; "Historic Landscape Restoration at Wilson's Creek NB" by Thomas; "Native Seedbank Project at New River NR" by Pollio and Davidson; and "Professionalism in Resource Management" by Jope.

book review

Paul Schullery, who has worked in Yellowstone NP as a ranger-naturalist, a park historian, a research consultant, and a technical writer, is represented on the new books shelves of the nation by three new publications: *Yellowstone Bear-Tales*, (Roberts Rinehart, Inc., 1991), *Pregnant Bears and Crawdad Eyes*, (published by The Mountaineers, Seattle, WA, 1991, 176 pp), and *The National Park Service:A 75th Anniversary Album* (Roberts Rinehart Publishers, 1991, 120 pp).

The Yellowstone bear book is a collection of bear observations and encounters beginning with one by Philetus Norris, who served as second superintendent of Yellowstone from 1877 to 1882, and wandering through notebooks, newspaper accounts, and research papers up to the 1950 piece by then Chief Park Naturalist David de L. Condon on "The Size of Grizzly Bear," enlivened and given continuity by Schullery's introductions and commentaries.

Pregnant Bears, "a book of processes" that explores why and how other life forms act as they do, was reviewed in *The Washington Post Book World*, Where Dennis Drabelle noted:

"Schullery's gift is for probing matters that most of us skip right over: the coordinated movements of wild flocks; swimming deer; predators that hang around backyard bird feeders; the attraction oF wildlife to roadsides. In *Pregnant Bears & Crawdad Eyes*, he develops these and a score of other topics into essays of high polish over solid substance."

And finally, the NPS 75th Anniversary Album is a delightfully "dated," authentic photographic history that portrays the people and places that have comprised what Wallace Stegner has called "the best idea we ever had" – the national parks. This handsome, cloth-bound book is an outstanding addition to the 75th anniversary celebration of the National Park Service. The quality of the old photographs speaks to the mastery of the picture-takers; the *clarity* of the pictures is startling to the modern viewer, and testifies to the air quality in those bygone days.

All three books are present now in most bookstores across the nation, although *Yellowstone Bear Tales* may be easier to find in and around Montana.

For this reviewer, a few additional words about *Pregnant Bears & Crawdad Eyes* are necessary: Paul Schullery is an adult expression of that most charming of all childhood stages – the walking question mark. His writing skills are as sharply honed as those of Lewis Thomas (his words carry meaning modestly without calling attention to themselves), and the overall effect is more a general paeon in praise of curiosity than a dissertation on any particular subject. He exudes childlike delight in the *pursuit* of knowledge. Instead of throwing facts at us from some lofty perch of erudition, he takes us cozily by the hand and suggests that we agree about how lucky we are to be peeking, poking, prying creatures, with the whole delightful Earth to ask questions of.

I lay this book aside and wonder if perhaps human evolution might be taking us toward the day when *all* of us will see our world/s – those "other nations, caught with ourselves in the net of life and time" – as worthy of our curiosity, our respect, and our loving carefulness. Paul Schullery, just for a magic moment, makes it seem possible.

Jean Matthews

Keystone Dialogue On Biological Diversity On Federal Lands Goes to Field

By John Dennis

In mid-April, 1991, The Keystone Center published its *Final Consensus Report of the Keystone Policy Dialogue on Biological Diversity on Federal Lands*, which provides the results of a 2-year multidisciplinary dialogue on biological diversity. In a June 21 memorandum, NPS Acting Director Herb Cables distributed the report to NPS senior managers and superintendents and strongly urged them to consider its findings and examine their own programs with respect to its recommendations.

The report's central thesis is that maintaining biological diversity on *all* federal lands is important. To establish the basis and urgency of its recommendations, the report provides information on the value of biological diversity to humans, the problems that impede its conservation, the criticality of federal lands to maintaining this diversity, and the key role that humans play. The report defines biological diversity as:

• The variety of life and its processes, including the variety of living organisms, genetic differences among them, and communities and ecosystems where they occur.

It identifies factors causing the loss of biological diversity to include actual and threatened extinctions of genotypes, populations, and entire species; loss of plant and animal habitats; spread of exotic species; and loss of natural biological communities. It suggests a national goal:

• To conserve, protect, and restore biological diversity on federal lands to sustain the health of the ecological systems, to provide for human well-being, and because of the intrinsic value of biological diversity.

The report also encourages federal agencies to coordinate their programs and to cooperate in conducting program evaluation, inventory, monitoring, research, data management, information transfer, planning, and budgeting activities that respond to the recommended goal. It discusses the need for identifying indicators of success to help people understand what conditions are desired and when the desired conditions are being achieved. It recognizes that achieving these recommendations may require additional funding and personnel.

It recommends specifically that each federal land management agency and each agency conducting activities on federal lands should pursue strategies cumulatively to meet all of the following seven related objectives:

• Maintain viable populations of the nation's native plants and animals well distributed throughout their geographic range.

• Maintain natural genetic variability within and among populations of native species.

• Maintain representative examples of the full spectrum of ecosystems, biological communities, habitats and their ecological processes.

• Increase scientific understanding of biological diversity and conservation.

• Achieve public awareness and understanding of biological diversity.

• Enable and encourage the private sector to develop and apply innovative approaches to the conservation of biological diversity.

In addition, it recommends that agencies should develop and implement mechanisms for coordination, including forming a Federal Biological Diversity Policy and Coordination Committee.

The report provides specific discussion and recommendations on such program topics as maintaining viable populations of native species; maintaining genetic variability; maintaining ecosystems, biological communities, habitats, and ecological processes; integrating conservation of biological diversity with other human needs; increasing scientific understanding; achieving public awareness and understanding; and encouraging private sector involvement.

Also, the report provides information about the five federal land managing organizations, including the National Park Service, that are responsible for managing most of the federal land holdings. Similarly, the report gives a synopsis of the Environmental Protection Agency and The Nature Conservancy. It offers information about the USFWS's "Gap Analysis" process, contains background information about genetic diversity and the relationship of selected biological traits to relative endangerability, and provides a glossary of terms.

The Keystone Policy Dialogue on Biological Diversity on Federal Lands involved personnel from federal agencies, Congressional staffs, environmental organizations, commodity organizations, private industry, and academia. Although supported by their parent organizations, these dialogue participants acted individually, not as representatives of their organizations.

NPS participants listed in the final report include John Byrne, Superintendent of the George Washington Memorial Parkway, now Project Manager, Appalachian Trail; John Dennis, Chief of the Science Branch, Wildlife and Vegetation Division, NPS Washington Office (WASO), and Mike Ruggiero, Chief, Wildlife and Vegetation Division, WASO.

Copies of the report may be purchased for $20 from The Keystone Center, PO Box 606, Keystone, CO 80435 (303)468-5822.

publications

From the Southeast Region come the following abstracts of recently published research reports/ documents.

Exotic Plant Species Management Strategies and List of Exotic Species in Prioritized Categories for Everglades NP. Whiteaker, Louis D. and Robert F. Doren. 1989. NPS Research/Resource Management Report SER-89/04, SERO, Atlanta, GA 30303. 21 pp.

Everglades NP presently contains an excellent example of southern Florida's original flora and vegetation. About 950 vascular plant species have been recorded, including about half the species endemic to southern Florida and numerous other rare plant species (Avery and Loope 1980, Avery and Loope 1983, Loope and Avery 1979). However, the plant communities and individual taxa of southern Florida have proved extremely vulnerable to disturbance from human acitivities. Deterioration began in the early 1900s and has continued, through agricultural development, urbanization, drainage, deliberate and accidental burning, and introduction of exotic species. Exotic plants have posed one of the greatest threats to

Seagrass Die-off Threatens Ecology Of Florida Bay

By Michael B. Robblee and W. Jill DiDomenico

Everglades NP is known for the numerous water resource problems assailing the integrity of its freshwater marsh and upland ecosystem. Less well publicized is that more than half the park is comprised of marine and estuarine habitats dominated by mangrove forests and shallow water seagrass meadows. These ecosystems, located at the end of the freshwater "pipeline," share in the stress visited upon the everglades by the diversion of water in south Florida for urban and agricultural use and for flood control.

Forida Bay, located between mainland Florida and the Florida Keys, is the largest of the park's marine systems. Perhaps symptomatic of the stress that it is under, Florida Bay has been experiencing widespread and occasionally rapid mortality of turtle grass, *Thalassia testudinum*, the bay's dominant seagrass.

Since 1987, an estimated 4,000 ha of dense *Thalassia*-dominated seagrass bottom in western Florida Bay have been denuded, and an additional 23,000 ha have been impacted to a lesser degree. Loss of seagrass habitat on this scale is unprecedented in tropical seagrass systems and potentially threatens the bay's water quality, its sport fishery, and its nursery function. This is because seagrasses serve as the dominant primary-producer and trophic base, provide shelter for animals, stabilize sediments, and influence nutrient relationships (Zieman, 1982).

An analogous situation, the eelgrass (*Zostera marina*) wasting disease, has been observed previously (Rassmussen, 1977). During the 1930s, eelgrass disappeared over much of its range along the east coast of the United States and in Europe, presumably due to an epidemic of a marine slime mold of the genera *Labyrinthula* (Muehlstein, *et al.*, 1987). Severe habitat alterations, disappearance of species dependent on eelgrass, and declines in fisheries were attributed to the eelgrass decline.

In Florida Bay, necrotic lesions on *Thalassia* leaves are often the first visible symptom of die-off. Short-shoots, vertical stems attached to the rhizome bearing leaves and roots, become chlorotic and leaves abscise or decay at the leaf base. Rhizome and root death seem to follow leaf loss at some sites. At other sites, however, below-ground tissue mortality apparently precedes visible leaf stress and death. *Thalassia* beds develop a mottled appearance as patches of chlorotic and dead seagrass enlarge and coalesce.

The rate of spread and size of die-off patches vary considerably among sites and appear to reflect variations in levels of naturally occurring stress in Florida Bay. At this time, seagrass die-off is known only to occur in dense grass bed habitats and apparently proceeds most rapidly in the autumn (Fig. 1A). At its worst, seagrass die-off can denude hundreds of hectares of dense turtle grass within several months; in its aftermath, only the stubble of dead short-shoots remain. After a period of declining water clarity and epibenthic algal accumulation associated with the decomposition of plant materials, recolonization of these former grass beds by the pioneering seagrass *Halodule wrightii* (shoal grass) is the first sign of recovery (Fig. 1B).

In 1988, the observed contagious distribution of die-off patches, the rapidity of the die-off process, and the recent resurgence of the eelgrass wasting disease along the east coast, strongly suggested that a pathogen may have been the primary cause of seagrass die-off in Florida Bay (Short *et al.*, 1986; 1987). It was feared that seagrass meadows regionally in south Florida would be affected, as was the case with the eelgrass die-off in the 1930s. This fear has not been realized yet, although a relatively virulent species of *Labyrinthula* has been isolated from seagrasses associated with die-off in the bay, and in the laboratory it has demonstrated the ability to cause necrotic lesions (Porter and Muehlstein, 1989). It remains uncertain at this time, but is considered unlikely, that a pathogen is the primary cause of what we are observing as seagrass die-off in Florida Bay.

(Continued on page 22)

Publications *(Cont. from p. 20)*

Everglades ecosystem integrity. This report lists 221 species of introduced plants that occur within the park and was created primarily by referring to the Everglades NP plants listed by Avery and Loope (1983), and further collections and identifications by the authors. The listed exotic plant species have been classified into 5 categories based on current distribution, potential to spread and invade native vegetation, and the corresponding management approaches for each group of species. This species list is intended for use by resource managers as a guide for exotic plant management strategy in Everglades NP and adjacent areas. It will be updated as necessary in conjunctin with mapping and site information that are part of the park's ongoing monitoring program.

Comparison of Economic Feasibility of Chemical Control Strategies on Differing Age and Density Classes of Schinus terebinthifolius. Doren, F. and Louis D. Whiteaker. 1990. Natural Areas Journal 10(1):28-34.

Schinus terebinthifolius (Brazilian pepper), which is native to Brazil, has become an aggressive, woody weed in southern Florida, displacing native vegetation and rapidly invading disturbed sites. Studies on the effective use of herbicides to control the plant began in 1982. Concurrent studies of the labor, time, and costs of control, using herbicides, were begun to determine the cost criteria for future implementation of *S. terebinthifolius* programs. Comparisons were made between different age and density classes and between matricide (killing female trees only) and complete control strategies. Stand structure also was evaluated. The numbers of trees and stems and amount of herbaceous cover varied according to age and stand density. The young successional sites average 1453 stems/ha and less than 14 cm understory height. Costs were directly related to numbers of trees and stems per unit area. Principal costs were labor, not herbicide, and did not vary significantly between matricide or complete control strategies.

A GIS Note From the Everglades

By Michael Rose, David Buker, and Frank Draugh

Editor's Note: On June 6, 1991, the A/D Natural Resources for the NPS sent a memo to all RDs on the role and function of the GIS Division. In part he said: "I acknowledge that implementation of the Servicewide GIS program objectives will take time and will require a significant commitment ... (but) I can point to early successes that reinforce our approach ... I am convinced that the Servicewide strategy developed by the GIS Division is a positive step, which strengthens the Division's partnership with the Regional Offices."

Everglades NP is a subtropical bank of biological diversity. Its 1.4 million acres of south Florida wilderness provides a sanctuary for flora and fauna from both the tropic and temperate zones. Geographic Information System technologies are being utilized by the park to integrate research databases into the natural resource management decision-making process for this national treasure.

Baseline databases are being developed for use by a variety of research and resource management projects. The park also has acquired high resolution photography and digital scanner data for the entire park area. These will be used to develop a vegetation map for the park. A project to develop freshwater hydrological themes on a regular basis also is underway. A variety of wildlife distribution databases, including wading birds, alligator nests, deer, Florida panthers, and manatees are on the systen, and many other databases are presently on the system of soon will be added. Many of these themes form the basic information needed to evaluate long-term changes in the park's plant and animal communities. Additional work directly addressing global climate change can be integrated with this existing information to predict and monitor effects on the park.

A number of studies of major importance to the park are using the GIS. One of these is evaluation of proposed changes to water management structures and management. Results of these analyses were documented in "An Assessment of Hydrological Improvements and Wildlife Benefits from Proposed Alternatives for the U.S. Army Corps of Engineers' General Design Memorandum for Modified Water Deliveries to Everglades NP" (June 1990).

The hardware includes a UNIX-based dual-processor Masscomp 6700 supermicrocomputer, a UNIX-based SUN SparcStation 2, a Polaroid ACT II color plotter, Tektronix 4596 Graphic printer, a Versatec electrostatic color plotter (36" format), Calcomp 9100 digitizer (36" by 48"), and a Calcomp 2300 digitizer (24" by 36"). The Masscomp system has two high resolution graphics display terminals, 1.2 gigabytes (GB) of fixed disk storage, a 1 GB read/write optical disk (with removable optical disks), a 45 megabyte (MB) cartridge tape drive, and a 9-track tape drive. The SUN system has one graphics display terminal, 2 GB of fixed disk storage, a 150 MB cartridge tape drive, and a 2.3 GB 8 millimeter tape drive. These two computers are on an Ethernet local area network, so data can easily be exchanged between the two systems.

GIS software consists of GRASS (Geographical Resource Analysis Support System) on both the Masscomp and SUN systems, ELAS (Earth Resources Laboratory Applications Software) on the Masscomp, and Arc/Info on the SUN, MAPGEN from USDA SCS on the Masscomp and SUN, and Home Range wildlife survey software on a PC. ORACLE database management system software also is presently available on the Masscomp, and soon will be added to the SUN, for both GIS and non-GIS related databases.

Rose is a Remote Sensing Specialist, Buker is Program Manager for Computer Operations, and Draughn is a GIS Specialist at Everglades NP.

Seagrass Die-Off

(Continued from page 21)

In 1987, Florida Bay may have been poised for seagrass die-off. Current thinking suggests that the synergism of several stress factors may have caused a production/respiration imbalance resulting in seagrass die-off (Zieman *et al.*, 1988; Robblee *et al.*, in press). First, Florida Bay,. which historically has averaged one hurricane in about every seven or eight years, has not experienced a significant hurricane since Donna in 1960 (Gentry, 1984). The lack of major storm perturbation in recent years may have allowed *Thalassia* communities to develop to very high densities and biomass, with consequent high respiratory demands.

Second, unusually warm autumn temperatures have occurred in the late 1980s; temperature anomalies were as great as 3 degrees C above a 50-year mean for Gulf of Mexico waters adjacent to Florida Bay. Relatively high autumn temperatures have kept seagrass respiration high at a time when productivity naturally declines with shorter days.

Third, seagrass roots and rhizomes exist in anaerobic sediments, so aerobic respiration is dependent on photosynthesis in the leaves. If the photosynthetic capacity of *Thallassia* leaves is reduced or plant respiratory demands increase, hypoxic stress may result. In Florida Bay, the risk of hypoxic stress is heightened because the calcium carbonate sediments in the bay are low in amorphous iron minerals, which precipitate dissolved sulfide. As such, sediment interstitial-water sulfide concentrations are high, with a correspondingly high chemical oxygen demand. Within this context of interacting stress factors, it is possible that disease functions as either an additional stress factor or as a disease agent attacking stressed seagrasses.

Many of the effects of seagrass die-off that were predicted previously (Robblee, 1988), have been observed. Most notable is declining water quality and increasing epiphytism over the past two years, especially in the vicinity of active die-off. Also, an increased frequency of fish kills has been observed in relatively stressed areas of Florida Bay that have been heavily impacted by seagrass die-off.

Poor water clarity and increasing epiphytism also are associated with areas of new die-off, where these factors are very likely promoting, at least in part, continued die-off. Reduced benthic fish and invertebrate abundances in areas of the bay experiencing die-offs have been documented (Robblee, 1989). In Johnson Key Basin, an area of dense grass beds in western Florida Bay suffering extensive die-off, abundances of pink shrimp, caridean shrimp, and small fishes have declined in seagrass habitats affected by die-off (Fig. 2).

Florida Bay may be the principal nursery ground for the Tortugas pink shrimp fishery (Costello and Allen, 1966). This fishery has experienced historic lows in the latter half of the 1980s, coincident with seagrass die-off in Florida Bay (Nance and Patella, 1989). This decline in an offshore fishery may reflect a decline in the health of Florida Bay, the inshore nursery ground.

Seagrass die-off research has been organized within a framework of cooperative studies. Individuals whose work and data are summarized here and who can provide detailed information on their research findings are: Dr. Paul Carlson and Michael Durako of the Florida Marine Research Institute, Florida Dept. of Natural Resources (sediment chemistry and plant morphology), Dr. Ronald Jones of Florida International University (nutrient relationships and water quality), Dr. David Porter of the University of Georgia (seagrass pathogens), Dr. Joseph Zieman and James Fourqurean of the University of Virginia (seagrass productivity and nutrient relationships), and Dr. Michael B. Robblee of the South Florida Research Center, Everglades NP (faunal relationships). This research has been supported by the NPS, the Florida Dept. of Natural Resources, and the South Floprida Water Management District. At this time research is scheduled to continue through FY '93.

Robblee is Acting Marine Program Director at Everglades NP; DiDomenico is a Biological Technician at the park's Research Center.

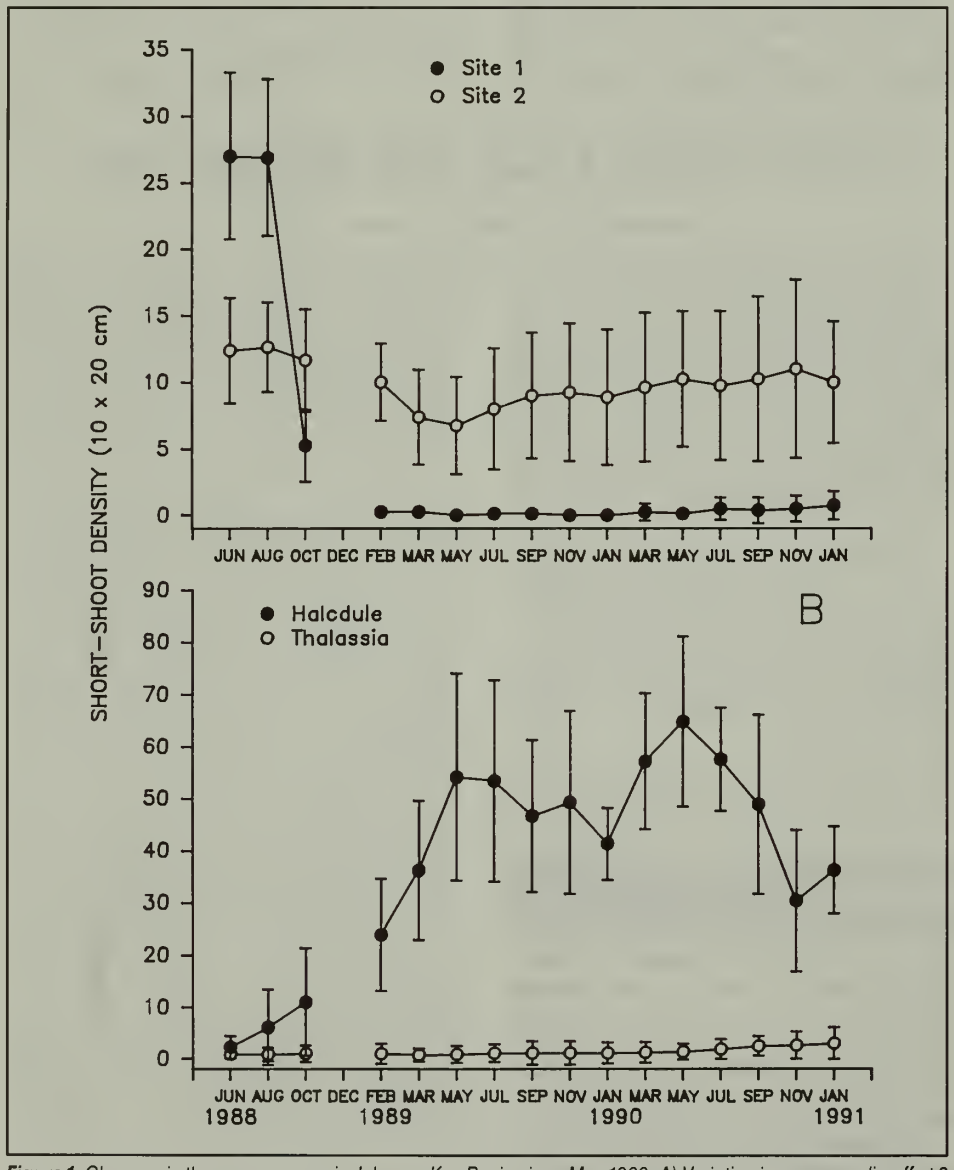

SHORT–SHOOT DENSITY (10 x 20 cm)
Site 1
Site 2
JUN AUG OCT DEC FEB MAR MAY JUL SEP NOV JAN MAR MAY JUL SEP NOV JAN
Halodule
Thalassia
B
JUN AUG OCT DEC FEB MAR MAY JUL SEP NOV JAN MAR MAY JUL SEP NOV JAN
1988
1989
1990
1991

Figure 1. *Changes in the grass canopy in Johnson Key Basin since May 1988. A) Variation in seagrass die-off at 2 monitoring sites initially exhibiting* Thalassia testudinum*-dominated, visually healthy seagrass. B) Recolonization of a die-off patch by* Halodule wrightii. *Data are mean ±1 sd short-shoot density in 8 replicate 200 cm² quadrats.*

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Seagrass Die-Off (Continued from page 22)

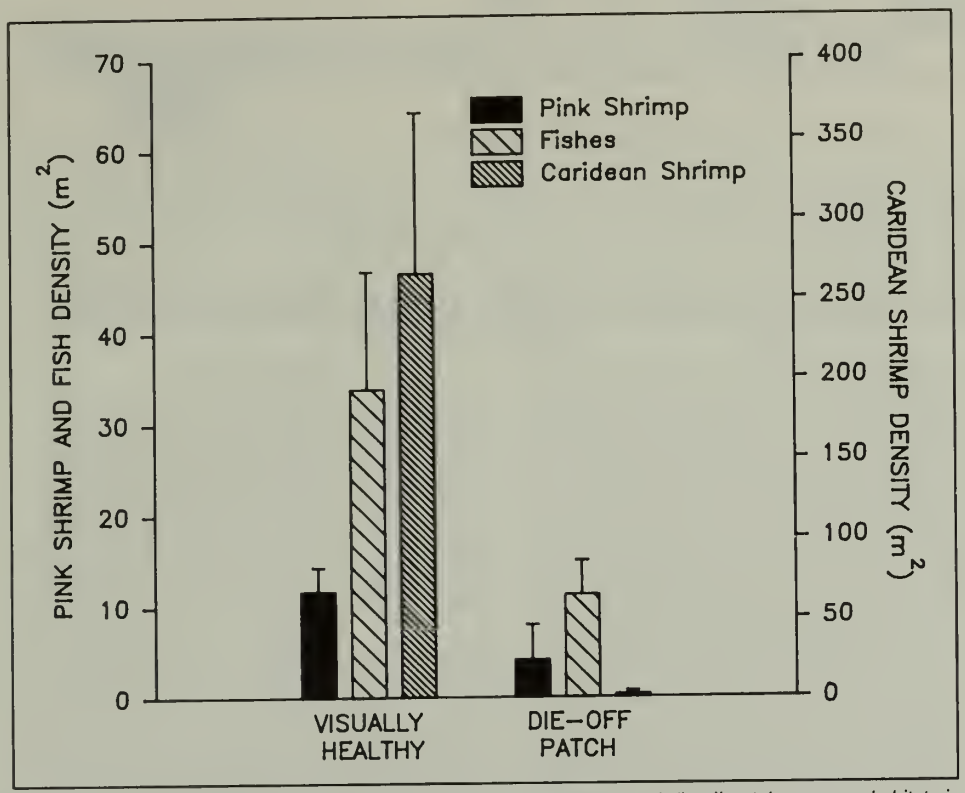


Figure 2. Comparison of animal abundances between visually healthy and die-off patch seagrass habitats in Johnson Key Basin in August 1989. Data are mean ±1 sd individuals/m² in 6 replicate throw traps.



Satellite images *of the Rabbit Keys in western Florida Bay document the spread of seagrass die-off between February 1987 and June 1988. In both panels black, grey, and white areas represent dense to sparse seagrasses. Dark lines evident in the white areas of upper and center right are deep water motes which partially surround Big and Little Rabbit Keys. The light patch evident in the center in June 1988 is a 49-acre area of severe die-off, dead-zone, which developed between late summer 1987 and spring 1988. An additional 295 acres of less severely damaged seagrass, patchy die-off, was also estimated to have occurred during this time.*

Where the Mind Runs Free: Observations of An Interpreter

Aural voyeurism (eavesdropping) is not deemed proper social behavior, but at times it can provide valuable insights. So the overheard comments of a couple at Dinosaur National Monument brought a lesson beyond what social research in parks could do.

The couple was viewing activities at the Quarry Visitor Center, where paleontologists were painstakingly exposing the spectacular fossil remains of a dozen species of dinosaurs and turtles.

"Well," said one, "if it is a hoax, it's sure an impressive one."

That comment, honest and revealing, bespoke the challenges to education in parks. What is said by interpreters is not necessarily what is heard; what is heard is not necessarily what is understood; and what is understood is not necessarily what is embraced within one's belief system. That colors the interpreters' strategies. "The canny art of intellectual temptation" is how Jerome S. Bruner described effective teaching – offering a tantalizing buffet and letting individuals decide for themselves which morsels they wish to taste.

As that couple revealed, the barriers to learning are real and formidable. "From our earliest years," observes Marilyn Ferguson, "we are seduced into a system of beliefs that becomes so inextricably braided into our experience that we cannot tell culture from nature." In a thousand ways, schools, movies, news, and families shape our constructs of reality. We accept most without questions and find ourselves comfortable with information that confirms our particular sense of reality. We are discomfited by what does not. Thus it is natural that many who visit parks seek to affirm their own concepts of history and the workings of nature. They seek corroboration, and it is most natural that they do.

But for decades now, a powerful transformation has been at work. As with the turning of an aircraft carrier, the changes have come without fanfare and with inexorable force. Based upon sound research, and using revelation as the fulcrum of learning, interpretation has profoundly shaped the expectations of travelers. This change in expectations cannot be overstated. At Hawaii Volcanoes NP, visitors can witness examples of evolution more dramatic than anything Darwin found in the Galapagos Islands. At Cape Cod National Seashore, travelers may discover that the Pilgrims, so often portrayed in heroic posture, possessed their ugly side. At Salinas Pueblo Missions National Monument, the story of missions and the missionary process reveals both sublime intent and manipulation of the indigenous people.

What people are discovering, then, is often at odds with their past training. For some this is unpleasant, and the gates to thinking close. For this shrinking minority, parks should display signs announcing: "Warning - Dangerous Ideas Ahead." But for others, this is the removal of a fog. They have embraced Carl Sagan's discovery: "We do not advance the human cause by refusing to consider ideas that make us frightened."

A legion of travelers now realizes the extent to which it has been taken in by an educational system; thus,

(Continued on page 24)

An Interpreter's Observations

(Continued from page 23)

the excitement with which parks are approached. Where once there was only light pleasure, blinders can be removed. Out of the tangible resources of parks, abetted by research and the building of extraordinary information bases, have risen intellectual resources – the most powerful resources of all.

"Since I first gained the use of reason," penned Juana Ines de la Cruz, "my inclination toward learning has been so violent and strong that neither the scoldings of other people ... nor my own reflections ... have been able to stop this natural impulse." The aspirations of Cruz, expressed in 1691, speak of opportunities recognized on an unprecedented scale. The "flight of the unfettered mind" is there, for those who seek it.

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DEPO ITEM
AUG
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Shenandoah NP Pilots Air Quality Advisory

By Rolf M. Gubler

An experimental Air Quality Advisory program, designed to increase public awareness of air pollution impacts on park resources and to alert visitors when ozone levels exceed EPA established health levels (.12 ppm) was undertaken by the National Park Service in 1990. Shenandoah NP, as one of the five parks that volunteered to participate in the pilot program, developed a parkwide ozone and visibility rating system and public advisory.

Shenandoah NP is located in a highly sensitive ecological area that is subject to air pollution originating from the industrialized areas of the east coast, midwest, and local sources within Virginia. The 1977 Clean Air Act Amendments designated Shenandoah as a "Class I" airshed and required the highest degree of protection for air quality related values. The amendments also gave the federal land managers responsibility for protecting the air quality values in Class I areas. The 1990 Clean Air Act Amendments left these provisions intact. However, in Shenandoah and other areas, continued urban and industrial growth is resulting in significant deterioration of air quality.

Visitors come to Shenandoah NP expecting majestic views of the mountains and valleys, but instead they frequently are treated to a heavy white haze shrouding the scenic vistas. Statistics show that summertime visibility in the Eastern United States has decreased roughly 50 percent in the last 40 years (the average current summer visual range is 15 miles). Seventy percent of the haze affecting visibility is due to manmade air pollution, mainly sulfate aerosols. This current chronic intense regionwide white haze condition is in direct contrast to the bluish natural haze historically associated with the Blue Ridge Mountains. Leaves of trees and other plants emit moisture and natural chemicals (e.g. terpenes) into the air, which react to form the natural bluish haze.

Another threat to natural resources and human health is the high concentrations of ozone during summer months. This threat can best be illustrated by the summer of 1988, when the park recorded two separate occasions during which the federal ozone standard established to protect public health was exceeded. At that time, we had no system for informing our visitors and employees of the potential health risks. With the park's new quantitative ozone rating system we can effectively alert visitors and employees when periods of unhealthy ozone levels occur.

To provide visitors with current ozone and visibility information, we have developed a parkwide Air Quality Rating System.

Every morning, ozone data are collected at the Big Meadows monitoring site and are polled via modem to the Natural Resources and Sciences Division Office. The highest one hour ozone concentration average is noted and converted into one of the three following classes: LOW 0.0 - 0.059 ppm, MODERATE 0.060 - 0.120 ppm, and UNHEALTHY 0.121 ppm or greater.

Our qualitative visibility indexes are determined at noon each day by noting the visual range to our western horizon. The observer is aided by the presence or absence from sight of known mountain ranges. The visibility indexes are: POOR = 0-10 miles, MODERATE = 11-30 miles, and GOOD = 31 miles or more. Visibility indexes are posted as visual ranges.

At 1:00 p.m. the ozone and visibility ranges are logged and transmitted via park radio to entrance stations and visitor centers. These locations represent our main public contact areas. Park rangers on duty there display the current ozone and visibility rating on the designated Air Quality Index signs and bulletin boards. If the ozone rating is unhealthy or becomes unhealthy, this information, along with an appropriate advisory, is broadcast parkwide as an administrative message. The health alert advisory urges healthy people to reduce their physical activity; the elderly and those suffering from respiratory ailments are advised to stay indoors.

Our policy at Shenandoah states that it is at the supervisor's discretion to decide whether to modify an employee's work activity. During periods of high ozone levels, we feel it is essential to provide our visitors and employees with this basic information.

To further educate our visitors, we've developed informative exhibits, displays, and site bulletins explaining the implications and effects of acid precipitation, visibility impairment, and ozone pollution.

Air pollution is not always the responsible agent when poor visibility occurs. Spring and Fall often bring low-lying clouds and fog that obscure views. However, except when there is a storm occurring or distinct clouds are in the area, it is not always obvious whether the visibility impairment is caused by weather conditions or pollution. What may look like fog may in fact be haze, and the only way to be sure is to analyze the filters in the fine particulate monitors. The filters must be sent away for analysis, making the fine particulate monitors unsuitable for use in the advisory program. Therefore, it is not our practice at this time to differentiate between human-caused and natural visibility impairment.

The Air Quality Advisory Program has been well accepted by the park staff and the public. Thorough local news coverage of the new system provided an ideal showcase for the program and enhanced its educational value. Staff from all park divisions worked together to make our program feasible and cost-effective. By creating greater public awareness of environmental issues through our Air Quality Advisory Program, we have found that we can serve the visitor more effectively and at the same time promote protection of our natural resources.

Gubler is an Air Quality Technician at Shenandoah NP.



Current ozone and visibility ratings *for Shenandoah NP are displayed at entrance stations and visitor centers at 1 p.m. each day.*

PARK SCIENCE

NATIONAL PARK SERVICE

SUMMER 1991

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

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Park Science is feeling the (pleasant) pressure of information overload. If you have submitted an article that has not yet appeared, or if your article appears in drastically curtailed form, our reason is simply that we have only 24 pages, four times a year. If we go to more pages, we lose the attention of our busy readers, who tell me they can scan 24 pages, but would balk at the much larger number we could easily fill. At present, our only option is to cut, trim, chop, and agonize. In our effort to cover the entire System, we cannot give many of the articles the length they really deserve. So we try to give enough to provide "the gist," and leave it to you who want more, to contact the authors.

Who knows? Perhaps 24 pages more frequently than every third month may become an option, but until that happy day we have to beg for brevity. Your editor is least happy when cutting, so please, do your best to do it yourself. Thank you.

editorial

The Natural Resources Publication Program is on track and running! Its coordinator, Donna O'Leary, describes it in an article beginning on this page. It provides the means for achieving order and retrievability in a science program that is rapidly coming of age within the Service. Scientific research, its reflections in natural resource management, and its interpretation to the visiting public are undergoing perhaps the most exciting changes of depth and direction in the history of the Service. The knowledge that is proliferating at this time is bringing powerful new options to light, providing our stewardship with insights and tools it never had before – and never needed so desperately.

The trick is how to keep this information current Servicewide – how to inform the field about what is going on so that discoveries need be made only once, mistakes need not be repeated, and the enthusiasm of local triumphs can spread through the System like friendly wildfire.

The publication program is an essential process for keeping track of what we are learning and putting this knowledge to its best and widest use. The new handbook is recommended reading for all and required reading for those who wish to make their imprint on NPS resource management history.

The Natural Resources Publication Program: What is it?

By Donna O'Leary

The Natural Resources Publication Program is a result of an initiative that began in earnest in 1987. It was in response to a request from the Chief Scientists to the Associate Director, Natural Resources (AD/NR), to improve the quality and ensure the credibility of NPS natural resources publications. The initiative began with numerous questions. Within the natural resource organizations, who was producing what? How many and what kinds of series existed? Who were the audiences? How were publications being reviewed? Who was accountable for approving reports?

To answer these questions and others, a survey was conducted on natural resource publications produced in FYs 1985 and 1986 and those proposed for 1987. The findings were most informative. Washington divisions and offices, regional offices, cooperative park studies units, and parks, together were disseminating an average of 148 reports/year through 15 series. The extent of reviews and the exercise of quality control varied from series to series. Most of the publications differed in appearance, format, series numbering systems, and distribution. No database information was available. No process existed for selecting publication projects. The publication situation was fragmented and lacked a coordinate direction, purpose, and focus.

To review and evaluate this information and to recommend improvements, the AD/NR set up a natural resources task force of scientists, resource managers including a superintendent, and editors. They met first in 1988. During the same period in 1988, and parallel to the natural resources publication initiative, the Director requested that a workshop of NPS editors and publishers be conducted to review and evaluate the entire NPS publication program and to recommend improvements. Most of the issues identified at the workshop were the same issues of concern for natural resource publications, including the following: "The natural resource publication program requires priority focus because of its present fragmentation."

The natural resources task force concluded that a comprehensive publication program was needed to provide a Servicewide function in disseminating information on natural resources through publication. To meet this objective, the task force recommended that (1) only a small number of series be used: six series disseminated at the national (Servicewide) level and three of the six at the regional level; (2) a publications coordination function be formalized; (3) a formal selection process be instituted for publication projects; (4) an advisory board be established to continue making program recommendations to the AD/NR and Chief Scientists; (5) a bibliographic database be generated and maintained for new publications; and (6) a policy and procedural handbook be developed to consolidate existing Departmental and other authorities and regulations and to provide additional guidance where needed.

(Continued on back cover)

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Biological and Physical Aspects of Dredging On Cumberland Island National Seashore

By Stephen V. Cofer-Shabica

Cumberland Island National Seashore (CINS), established by Congress on Oct. 23, 1972, is well known for its marine turtles, abundant shorebirds, dune fields, maritime forests, fishing, marshes and tidal creeks and flats, and historic structures. CINS is 25.7 km long and totals 13,342 ha, of which 6,821 ha are marsh, mudflats and tidal creeks. It was established to preserve the scenic, scientific, and historical values of the largest and most southerly island off the coast of Georgia (PL 92-536, 92nd Cong, S.2411.)

The Kings Bay Environmental Research Program was conceived in 1986 by the U.S. Departments of Interior and Navy to evaluate the relationships between submarines and their shipping channels, marshes, barrier island shorelines and dunes, notably those of CINS, Georgia and Amelia Islands (Florida), and tideflats. The Program focuses on the potential effects of the deepening, from 12.7 m to 15.5 m, of the Kings Bay Trident Submarine Base ship channel. The channel is almost 35.2 km long, extending from Kings Bay, through Cumberland Sound, out the St. Marys Entrance to the 15.5 m contour, 19.2 km offshore. The removal of approximately 26.8 million cubic meters of dredged material was required.



***Trident submarines** are almost 600 feet long, have a complement of 110 sailors, and carry 12 missiles each, armed with 10 independently targeted nuclear warheads. The U.S. has 30 Trident submarines, 10 of which are based at Kings Bay, GA, adjacent to Cumberland Island National Seashore.*

Coastal Monitoring Plan

A 5-year study (1988-1992) was set up to perform environmental monitoring in the area of Cumberland and Amelia Islands and Cumberland Sound. This Program, currently in its third year, is funded at $900,000 per year. The ecological aspects and overall synthesis of the monitoring program are the responsibilities of Interior, with the National Park Service as the implementing agency, Stephen Cofer-Shabica the Program director. Navy is responsible for monitoring the physical aspects of the study area with the Naval Facilities Engineering Command as the implementing command. The physical monitoring program includes both coastal and estuarine studies and is performed for the Navy by the U.S. Army Engineers.

The primary purpose of coastal monitoring is identification and quantification of any cause and effect relationships between the entrance channel modification and the ocean shoreline. A 3-fold study plan includes review of the historical setting and pre-project data to document the long-term evolution of the project area, data collection during the 5-year program to identify changes, and numerical modeling studies to extrapolate the measured process-response to scenarios beyond the measurement period of resolution.

Monitoring Activities

An intensive historical study gathered survey, sediment, geologic, aerial photography, map, dredging, wave, and process measurement data from numerous sources including the National Ocean Service, the States of Florida and Georgia, both area Corps of Engineers Districts, and the professional literature. The bulk of this study concentrated on evaluating the historic bathymetric surveys and shoreline change history in order to identify regional and local trends and anomalies. The historic sediment transport patterns, rates, and processes were conceptualized and a first order sediment budget developed.

Monitoring activities include (1) funding the 4.5 year operation of a 3-meter National Data Buoy Center offshore directional wave gage in 65 ft (20 m) of water at Wave Information Study station #57, (2) installation of nearshore directional wave gages off Cumberland and Amelia Islands, (3) annual surveys of beach profile and offshore lines on Cumberland and Amelia Islands, (4) winter or half-year surveys of about 15% of these lines, (5) annual surveys of the wetlands, shore and near shore on the soundside of Cumberland Island, (6) beginning and end of the 5-year period surveys of St. Marys ebb tidal delta, (7) aerial photography (joint activity with the NPS), (8) sediment sampling, and (9) annual data analysis and interim report preparation.

Estuarine Monitoring Plan

The estuarine studies consist of six main elements, but unlike the coastal studies these elements are planned as independent activities. Extensive physical and numerical model studies were performed and field data collected in support of the Trident channel design program. The scope of the estuarine studies was influenced by this existing study base and the interrelationship of the physical processes with the ecological studies which Interior had planned in the same area.

During the entire 5-year period there will be continuous monitoring of the tides, conductivity, temperature, salinity, and suspended sediments at six stations throughout the estuarine system. In addition, an intensive hydrodynamic sampling activity was conducted in 1990 over a 13-hour cycle. This study duplicates concentrated sampling studies conducted in 1982 and

(Continued on page 4)

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Effects of Dredging on Cumberland Island

(Continued from page 3)

1985. The Sediment Sources and Redistribution task modified the previously archived numerical model study of the estuary to include all elements of the "as-built" project and compare the base-to-plan condition to identify any sedimentation redistribution effects. In 1989 a preliminary statistical analysis of the Long-term Fernandina Tide Gage record was conducted to determine if there is any evidence over the 50-year tide record to relate changes in the tidal prism to historical channel expansion.

Biological Monitoring Program

Marsh, Mudflats and Tidal Creeks: The mudflats and tidal marshes and creeks are highly important to the Cumberland Sound ecosystem, providing habitat and foraging and shelter areas for numerous vertebrate and invertebrate species, including the endangered wood stork and manatee. These areas also are important in nutrient recycling. Interference with sediment deposition, both in terms of quantity and quality, could result in drowning of the marshes as sea level rises, and increase shoreline recession. The purpose of this study is to determine whether backbarrier dredging for the Kings Bay Submarine Base is affecting marsh habitat stability on Cumberland Island. Research was predicated on the hypothesis that if this operation is indeed exerting an influence on Cumberland Island, it will most likely be first perceived in the effect it has on the rates of supply and delivery of sediments to marches and tideflats.

Population Dynamics of the Hard Clam, Mercenaria mercinaria: It is possible that the construction and subsequent deepening of the entrance channel to the U.S. Navy's East Coast Trident Submarine base at King's Bay, GA, may have altered environmental conditions in Cumberland Sound sufficiently to affect native marine invertebrate populations. Possible changes could come from alterations in water quality, in sedimentation rates and types of sediments on the eastern and southern shores of Cumberland Island, erosion and steepening of the banks on the western shore, and changes in suspended sediment loadings. The hard clam, *Mercenaria mercenaria*, is being used in this study to compare historical and current growth rates, physiological stress, and reproductive effort between clams in "impact" (tideflats in close proximity to the ship channel) and "non-impact" control sites (tideflats far removed from the ship channel, but of similar physical and geomorphological characteristics).

Groundwater Hydrology: Channel development which intercepts the edge of the surface-water lens and/or the Pliocene-Miocene aquifer could result in loss of water confinement causing alterations in the groundwater resources for the island. Such changes include lowering of the surface- and ground-water tables, and salt water intrusion. Since the plant and animal communities of the island are dependent on the quantity and quality of the surface- and ground-waters, adverse changes in this resource would have adverse consequences for the Island's ecology. The placement of a series of shallow 4.5 m to 39.4 m water monitoring wells in the surficial and Pliocene-Miocene aquifers of Cumberland Island and the determination of the island's water budget will permit an evaluation of changes in the freshwater resources of the Island as they might be related to the deepening of the Kings Bay ship channel.

Manatee Presence in Cumberland Sound: Five radio-tagged manatees, three tagged in Brevard County and two in Nassau County, moved into the Cumberland Sound region during the summers of 1987 and 1988, and were tracked there. With Navy funding, tracking of manatees in Cumberland Sound was continued during the 1989 season. This is the first ecological study of the Florida manatee outside of Florida. Purpose of the study was to determine how long manatees stay in the Cumberland Sound region, and to determine if military activities, such as dredging or increased boat traffic, are likely to affect manatees or manatee habitat.



***Waves break** on the shoreline of a Cumberland Island marsh.*

Geologic History of Cumberland Island Marshes: The mudflats and tidal marshes and creeks are highly important to the Cumberland Sound ecosystem. Interference with sediment deposition, both in terms of quantity and quality, could result in drowning the marshes as sea level rises, and increased shoreline recession. In question is whether the deepening of the channel will affect the marshes of the Cumberland Island ecosystem. To answer this question it is necessary to know how the marshes existed in the past, how they evolved, and what environmental factors affected this evolution and development. Purpose of this study is to investigate and document the historical evolution and development of the marshes, mudflats, and marsh tidal creeks of Cumberland Island and vicinity for the last 3,500 years.

Aerial Photographic Surveys: Using high resolution metric A0Aaerial photography to establish the current state of the beaches and barrier island seashores, future changes can be identified through additional aerial photographic surveys. This annual series of photography is also being used to evaluate marsh productivity. All photography conforms to pre-set flight lines and includes all of Cumberland Island and the shoreline of Amelia Island. Aerial photographic missions are flown by NASA using the high altitude ER-2 aircraft. The plane flies at 19,400 m and provides distortion-free stereo photographs. The aircraft is equipped with the RC-10, 9" x 9" format camera, the HR 732 Hi-con, 9" x 18" format camera with 24-in. lens, and the Daedalus Thematic Mapper Simulator. Products are color, color infrared, and black and white photographic transparencies, negatives, and prints.

Wading Bird Habitats and Populations: The breeding population of Wood Storks *(Mycteria americana)* in the U.S. declined from an estimated 20,000 in 1930 to less than 5,000 just 50 years later. With the continued destruction of the Florida Everglades, Wood Storks have been reported breeding on the Georgia Coast since 1977. The habitats used by Wood Storks for foraging are subject to disturbance by island visitors and by the dredging activities in the vicinity. Of particular concern is the possibility that dredging induced changes in hydrology and/or erosion may reduce the availability of Wood Stork foraging habitat. The study's purpose is to determine the relative use of various habitats as foraging areas by Wood Storks, and to investigate the factors involved in foraging habitat choice.

Program Review and Oversight

A technical Review Committee composed of representatives from the Naval Facilities Engineering Command, the NPS, the States of Georgia and Florida, and university consultants meets twice yearly to review project and program progress and direction. Recommendations are made to an Interagency Steering Committee (from Interior and the Navy), which then makes final decisions.

In summary, the goal of this research is to document the potential for short- and long-term changes on the resources of Cumberland Island and Cumberland Sound estuary. The monitoring program has been in effect for approximately three years for the Navy (2 years for Interior), and immediate data sets and analyses can not be used at this time to summarize or identify any trends.

Cofer-Shabica is an oceanographer at the NPS/CPSU, Institute of Ecology, U/GA, Athens 30602; (404) 542-1438.

Global Change Funds Allocated

Six biogeographic areas have received base funds and funding for one or more research projects under the Global Change program. The six are Colorado Rockies, Glacier NP Area, Olympic Peninsula, Ozark Highlands, Southern and Central Sierra Nevada, and Western Lake Forest.

A GIS Assessment of Barrier Island Impacts

By Samuel Patterson and Richard Dawson

Coastal landforms are the interface between aquatic and terrestrial ecosystems; as such, they tend to be dynamic in terms of geomorphological change. Changes in coastal and barrier island landforms range from the impacts of storms and tidal action to human-induced changes brought on by dredging and other coastal engineering projects.

For the most part, national parks located on barrier islands or coastal lands have been managed with little definitive knowledge of the regions outside of park boundaries, or of the impacts development of adjacent areas have had on the ecological integrity of the parks. It is becoming increasingly apparent that national parks, whether they are located on barrier islands or coastal lands, are not discrete, isolated landscapes unaffected by development of the surrounding regions. Although they often are perceived as undisturbed refuges, national parks are being impacted negatively by adjacent private development and government sponsored projects.

Particularly damaging to coastal and barrier island NPS areas have been large-scale dredging and spoil disposal, coastal engineering projects (Dean 1988) and oil spills. In many cases, accurate and quantifiable assessment of these impacts to coastal and barrier island geomorphology, hydrology, shoreline erosion, aquatic and terrestrial ecosystems has been inadequate or incomplete.

The proximity of NPS barrier islands to major dredge and disposal operations, oil drilling, and oil transport, has necessitated the involvement of the Service's Southeast Regional Office (SERO) in long-term inventory, monitoring, prediction, and evaluation of impacts. Examples of national seashores impacted by such projects are Cumberland Island (St. Marys Inlet/ Kings Bay Naval Submarine Base), Cape Hatteras (Oregon Inlet), and Gulf Islands National Seashore (Pensacola, Pascaguola, and Gulfport channels). Preproject evaluation of and response to the short- and long-term impacts associated with these projects and with oil transport is critical for the continued viability of coastal and barrier island national parks.

SERO has recognized the need for a comprehensive system that can incorporate both regional and park monitoring data, scientific research, hard copy maps, digital information, aerial photography, digital imagery, databases, predictive models, and decision tree responses under one, integrated, turn-key approach. The SERO and the University of Virginia Department of Environmental Sciences are developing a coastal barrier island remote sensing, monitoring, and GIS program to function in concert with existing scientific research and resource management databases. The program also is fine tuning several sediment transport models and developing a decision tree response model for oil spills to function with the GIS.

Global Positioning Systems

National parks in these coastal areas pose several problems for researchers conducting field work and for GIS specialists creating an accurate park geographic information system. Scale related phenomena become very important on coastal lands and barrier islands as evidenced by vegetation communities, which tend to occur along narrow, linear bands that can be as little as 3 to 5 meters wide. To create a GIS with multiple themes, development of data bases within the following areas are required to provide robust themes and analytical models.



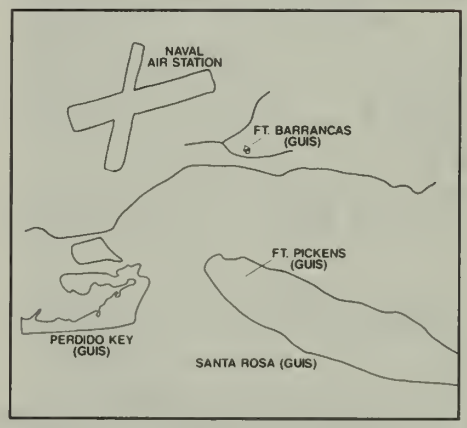
Problems facing barrier island managers *can be seen at Pensacole Channel (Gulf Islands N.S.). Need for increased navigational access, Naval Air Station (top center); protection of significant historical resources, Fort Pickens (right); and, preservation of natural features threatened by increased erosion due to channel dredging, Perdido Key (left).*

Before the aerial photography could be flown, another significant problem had to be addressed. Because barrier islands tend to be isolated and due to their dynamic geomorphology, they possess few identifiable ground control points. In some areas, georectification of barrier island aerial photography can be very difficult due to the paucity of permanent structures, roads, and other identifiable land features.

A comprehensive network of mapped and registered ground control targets and permanent monuments whose accuracy exceeded USGS National Map Accuracy Standards was installed, to provide ground control points for rectification of the aerial photography. Precise registration of the ground control points was effected by a Trimble Surveyor global positioning system (GPS). When present, permanent structures also were registered by the GPS for later use in the georectification process.

Remote Sensing

The SERO remote sensing missions are being flown by NASA from 1990 to 1993 and consist of several high performance cameras, three film types (black and white, color infrared, and color), and a Daedalus 10 band digital scanner. The cameras employed on these missions (HR-732 and RC-10) and Daedalus digital scanner have a ground resolution of approximately 1 meter, 3 meters, and 20 meters, respectively.



Unlike smaller remote sensing platforms, the ER-2 aircraft carries all 4 imaging devices simultaneously. The variances of altitude, sun angle, time of day, time of year, and different flight dates thus are eliminated in this multi-platform vehicle. Simultaneous platform imaging removes some very critical problems and biases that usually plague development of accurate spectral classification ranges in image processing of scanned aerial photography. Photographic ecological atlases of each barrier island park are being developed from the 3-meter resolution aerial photography.

The NPS areas incorporated into this remote sensing, mapping, and GIS program, include Assateague, Cape Lookout, Cape Hatteras, Cumberland Island, Canaveral, Biscayne, Timucuan, Virgin Islands and Gulf Islands. The NASA flight missions will be repeated over the next 2 years to monitor impacts from dredging, and to assess changes in island vegetation and migration (accretion and prograding) of the islands. The

(Continued on page 6)

A GIS Assessment of Barrier Island Impacts

(Continued from page 5)

imagery also will be used to create digital GIS change detection maps for temporal and spatial analyses.

Image Processing

NASA aerial photography of the barrier islands from the summer of 1990 is being converted digitally by an Optronix scanner at a resolution of .8 meters (2000 dots per inch). Extensive testing was conducted to determine the optimal spatial resolution for delineation of the narrow barrier island vegetation communities. The NASA photography is of such high resolution that individual trees from the same community can be differentiated. Scans of such high resolution can create problems when performing supervised or unsupervised image classifications, because one community may be broken into several identified classes. A vegetation classification scheme of 20 classes has been adopted for the NPS barrier islands.

The scanned aerial photographs are georectified with coordinates derived from the GPS ground control targets that were laid out prior to the flights. Permanent structures visible on the aerial photographs also were registered by the GPS for use in the georectification process. The georectified scans will be edge-matched and "zipped" together. Following supervised classification of the vegetation communities, all the individual scans will be joined seamlessly to create a georectified vegetation data layer of each barrier island.

Geographic Information Systems

Remote sensing and mapping analysis of island migration and vegetation composition over time can give scientists and resource managers an outlook on barrier island previously not possible. The incorporation of remote sensing imagery with other digitized GIS data layers can provide unique insights into island dynamics and interactions between the hydrology, ecology, geomorphology, and human impacts. GIS data themes can be viewed as a single data layer or as part of a composite overlay format.

The major themes of the GIS are: vegetation (derived from image processed aerial photographic scans, National Wetlands Inventory Maps, and NOAA seagrass maps); geomorphology (from current photographs, shoreline erosion, beach profiles, and digital line graphs); fauna (from USFWS Ecological Inventory maps), adjacent land use (from Minerals Management Service Ecological Characterization studies); and cultural resources (from NPS Cultural Sites Inventory and List of Classified Structures).

Digital Line Graphs

Digital line graphs (DLG) at the 1:24,000 scale are needed for assessing change in the geomorphology and the location of the barrier islands over time. Most DLGs for coastal areas of the Atlantic and Gulf of Mexico were mapped in the early 1960s. Storms and dredging operations have significantly altered several of these islands. Availability of these maps in a digital format would provide researchers a 1960s window to compare with 1990 data being derived today. Change detection analysis between the two dates could yield useful information about island position and areal extent. Maps not available from USGS in DLG format will be scanned by automated techniques retaining the topological elements of the data theme(s) of interest, which then are inported into the GIS (Fain 1989).

Inlet Dredging Impact Model

Historic aerial photography, shoreline erosion, spoil disposal sites, and geophysical data are being collected from the Corps of Engineers for coastal and barrier island inlets that have been dredged. Extensive information exists on dredging projects conducted adjacent to barrier island national parks (Dean 1988). The model will account for the physical parameters existing at each inlet such as history of dredging at the site, sediment transport rate, volume of sediment available, and direction of transport. Incorporation of these parameters into the model will provide estimates regarding the effect of sediment removal (dredging) or sediment interruption (jetty) on the "downstream" island in terms of area affected. Once this affected area has been identified then data from the various GIS themes will be listed to display the resources that would be impacted.

Oil Spill Decision Model

The SERO and the Department of Environmental Sciences at U/VA are developing an oil spill decision support model (Psaraftis and Ziogas 1985) that is based on contingency planning and response (Etkin 1990), and impact prediction and damage assessment (Psaraftis et al. 1986). Detailed information regarding oil types, estimation of flow volume and direction, time of year, climatic variables, sources of abatement/cleanup equipment and personnel, and response protocol (mechanical devices, dispersants, bioremediation, etc.) will be included in the decision support system model.

The Gulf region model will be assessed in terms of reponse capabilities and limitations, hierarchy of rapid response teams and contacts, environmental sensitivity of the shoreline to oil types transported through the Gulf, and relevant economic factors. The model will be validated by current risk assessment data derived from actual oil spill data and will be tested against low, mid, and worst case scenario spills for oil type and volume, from least to the most susceptible islands.

Conclusion

Remote sensing and GIS technologies, when coupled with other sets of information and field data, represent a powerful tool for quantification of impacts to coastal and barrier island national parks. The future of effective impact forecasting in dynamic areas like barrier islands resides in the use of predictive GIS models that have been updated with monitoring data and tested against historical suites of monitoring data and scientific research.

Patterson currently is a graduate student in the Environmental Sc8iences Dept., U/VA, Charlottesville, VA 22903; Dawson is with the NPS Southeast Regional Office, 75 Spring St. SW, Atlanta, GA 30303.

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Ecological Restoration Research: Applications Manual

By Destry Jarvis

The Student Conservation Association (SCA), with more than 30 years experience in the field, is researching and preparing a manual for ecological/disturbed site restoration. This manual will be designed for use by managers and restoration practitioners of uplands and wetlands throughout the country and will incorporate restoration research with practical application methods. Case studies of representative physiographic sites will be included. The manual, to be published in the spring of 1991, will provide principles, methods, and examples for effectively restoring disturbed sites.

Restoration increasingly is viewed by researchers and managers (though perhaps not by environmentalists as a group) as a paradigm for land management. As the traditional conservation movement evolves into a more broadly based environmental perspective, so too has the traditional conservation goal of wise use given rise to modern prescriptions. Currently, the environmental movement is working predominantly toward the goal of preservation – the prevention of further resource and amenity degradation. Yet within certain communities, degradation has occurred to such an extent that restoration becomes an important conceptual tool for normative policy and managerial use.

SCA's disturbed site restoration manual will survey the historical, philosophical, and social structure of the current ecological restoration movement. It will advocate that restoration does not compete, but rather augments, the traditional environmental goal of preservation.

Previous land management paradigms have included reclamation, rehabilitation, reforestation, and remediation. These often have been practiced without the ecological worldview that restoration adopts. Thus, SCA's manual on ecological/disturbed site restoration will make use of illustrative ecological principles such as "associations," "diversity," and "productivity." The restoration ecology worldview espoused in SCA's manual will advocate the beneficial use of native species, integrated pest management, and appropriate methods for sensitive ecosystems.

Recent research regarding the ecological constraints of restoration will be surveyed, as will representative techniques and applications by physiographic regions. Physiognomic characteristics as they relate to specific restoration plans will be highlighted.

An advisory committee of restoration ecology scientists and restoration practitioners will oversee the drafting and content of this manual. Communication from interested individuals is encouraged. In addition, case studies of hand-tool scale restoration projects are solicited for inclusion. These should be no longer than 4 double spaced pages and include detailed methods.

Submissions cannot be returned and are subject to editing. Address inquiries to Douglas Olds, Manual Editor, SCA, 1800 N. Kent St., Suite 913, Arlington, VA 22209.

Jarvis is Executive Vice-president of SCA.

Arid Veg Management: A Multi-Agency Look

By Jean Matthews

Arid vegetation management – three precise words that encompass a myriad of imprecise problems – recently brought together a congeries of the Northwest's premier practitioners in state-of-the-art revegetation principles and techniques.

A May 14-15 workshop, hosted by the John Day Fossil Beds National Monument (JODA) in eastern Oregon, featured expert leadership from the Bureau of Land Management, the Soil Conservation Service, Oregon State University, the NPS/CPSU at U/ID, Nez Perce NHP, Whitman Mission NHS, NPS Pacific Northwest Regional (PNR) headquarters, and the JODA park staff. Participants spent two days sharing data, techniques, theories, and field results, discovering one another's unique capabilities for developing and implementing effective arid lands management.

Steve Gibbons, PNR Natural Resource specialist and workshop coordinator, kicked off the proceedings with a run-through of NPS mandates and management policies – a recurring subject as field managers described the practitioners' views on these imperatives.

Prudent flexibility in the evolution of both policy and practices emerged as an efficient working process. If policy says that something can't be done, but practice finds that it **must** be done, then creative management that is true to the spirit of policy mandates seems to be evolving as the pragmatic path to desired results. Merging perspectives – from variously involved agencies at federal and state levels, from universities, and from local "participants" in the managed land scene – have brought both wisdom and workability to the sometimes agonizing process of restoration.

Larry Larson and Boone Kauffman, from the OSU Department of Rangeland Resources, led the workshop discussions and field trips on weed control and fire ecology research, respectively. Sue Burnworth of the Soil Conservation Service (SCS) described "Native Plants for Parks," a cooperative program between the SCS and NPS that makes available to NPS the expertise and plant materials from 26 SCS plant materials centers around the U.S.

Rocky Beavers, NPS Technical Advisor for revegetation projects, (at the NPS Denver Service Center) will contribute an article on plant materials for the fall issue of ***Park Science***. Kauffman and Larson have promised to deal in some detail with the art of returning disturbed areas to native plants and the role of fire in restoring natural ecosystems.



A return to native grasses *at Whitman Mission NHS was accomplished thanks to the flexibility of NPS management policy that now allows the use of plant materials "historically appropriate for the period or event commemorated." Basin wild rye grass – the original stand – was impossible to achieve following the pigweed, cheatgrass, and yellow starthistle invasions that had resulted from years of human disturbance at the site. But native bunchgrasses and fescues, shown here, give much the same aspect to the site as the original stands of basin wild rye. (Walla Walla Union-Bulletin Photo by Jeff Horner)*

Historic Landscape Restored

Historic landscape restoration is underway at Wilson's Creek National Battlefield. The aim is to return the historic core of the park, after 100 years of farming, to the mosaic of oak savanna, limestone glades, and riparian forest that formed the landscape in 1861. Park staff will concentrate on 330 acres in the park's northwest section, which contains the most significant cultural and natural resources and is a focal point of visitor use.

Restoration will rely on fescue eradication and seeding of savanna species in pasture areas, Osage Orange removal in successional forests, and forb introduction in established warm season grass plantings. Because periodic burning played a role in maintaining the savanna landscape, prescribed fire will be used extensively in the restoration.

Jordan's View of Restoration

"A botanist walking through the John Curtis Prairie today couldn't tell it from the original prairie. That's partly because no botanist today has ever *seen* an original prairie. The original tall grass prairies exist only in books, and these books are an important part of the DNA for ecological restoration."

The speaker was William Jordan III, editor of ***Restoration Management Notes***, executive secretary of the recently formed Society for Ecological Restoration, and keynote speaker at the Feb. 22, 1991 opening day of Cascadia Conference for designing, maintaining, and restoring natural landscapes. The conferees, gathered in Portland, OR, were listening to Jordan describe the restoration of a 60-acre prairie plot at the University of Wisconsin/Madison Arboretum.

"In tiny plots, here and there, we found – still clinging to existence – scraps of 'the living dead'," Jordan said. "The cryptic prairie, in the form of glacial relics, is still struggling along in the shade of oaks. These scraps can be brought back by cutting the trees and burning the prairie. The pieces of the puzzle still exist and we can coax them back into sturdiness and put them together. By doing so, we can build our soils, preserve the plants, and bring back some of the original regional flavor," Jordan said.

Not only can restoration by the use of native plants save on labor, fuel, and exercise, Jordan noted, but such restoration is the basis for creating a healthy human relationship with nature. Aldo Leopold called restoration a mutually beneficial relationship. Thoreau, in ***Walden***, exhorted mankind to "reenter Nature."

Jordan described three types of relationships with nature: personal, historical, and celebratory. By participating in ecological landscape restoration, he said, one can become a functioning, working *part* of the landscape, "inhabiting it in an ecological way."

The process of restoration traces, in a way, our human history, Jordan said. It begins with hunting and gathering the relict species, evoking the primitive "hunter/gatherer" psychology. It progresses to the agricultural/gardener stage, and finally it reaches the scientific level, where it explores the deep human cultural past in its ritual entirety. "It tells us," Jordan said, "that restoration is a performing art, and that in the performance, we discover our reciprocal relationship with nature. When it is complete, we will have learned to DO it, and to CARE about doing it."

Tallgrass Prairie Site Studies

The NPS has completed a special resource study of the Z-Bar Ranch – a 4,409 ha cattle ranch near Strong City, KS, which contains extensive tracts of tallgrass prairie and several buildings listed on the National Register of Historic Places. The study, in response to a request from the Kansas delegation to the U.S. House of Representatives, was conducted in two phases: a study of significance and a study of alternatives.

The significance study found that the natural and cultural resources of the ranch qualified it for both National Historic Landmark and National Natural Landmark status and therefore made it suitable as a potential addition to the National Park System.

The study of alternatives identified five, under which the NPS believes the ranch could be managed: (1) no action, continued private ownership; (2) Flint Hills/Z-Bar Ranch National Historic Site; (3) Flint Hills Prairie National Monument; (4) Protection of the Z-Bar Ranch by State or Local Government Agency, and (5) Private Conservation Organization Reserve. The NPS takes no position on which alternative should be pursued.

Mountain Goats in Yellowstone: The Horns of a Dilemma?

By John W. Laundré

In the 1940s and '50s, personnel from what was then the Montana Fish and Game Department introduced mountain goats *(Oreamnos americanus)* into several areas north of Yellowstone NP, primarily to increase recreational opportunities for hunters. Little did the Montana personnel of that day dream that their actions would result in a major dilemma for the National Park Service.

Mountain goats are part of the native fauna of several mountain ranges in Montana, Idaho, and Washington, but by all available information they did not occur historically in the Greater Yellowstone Ecosystem. Because of the transplants made by Montana personnel, there are now goats in the Yellowstone Ecosystem and descendents of these transplants now are on the verge of colonizing the park.

Goats moving into the park present a major conflict with NPS mandates that stipulate the preservation of native faunal and flora complexes. Introduction of "exotic" species into an area usually occurs at the expense of native species; consquently, exotic introductions are viewed as a threat. Because of this negative impact, NPS policy stipulates exotic species must not be allowed "to displace native species if this displacement can be prevented by management." (Anon. 1988).

So the decision would seem to be straightforward: Goats are exotics; as such, they should not be allowed to become established in the park. However, it turns out not to be as simple as it seems. Two factors complicate the issue. Goats ARE historically native to areas as little as 60 km to the west of the Yellowstone Ecosystem – areas ecologically similar to the Ecosystem. It remains a mystery why the relatively high mountain passes would have acted as a barrier to "natural" movement of goats to the east.

Regardless, mountain goats cannot be considered ecological exotics to the faunal and floral complexes found in the Yellowstone area. Animals and plant species similar to those found in the Ecosystem have evolved with goats in close proximity. One might argue that the specific animal and plant populations in the Yellowstone Ecosystem didn't evolve with goats and so may not have developed the defenses found in populations sympatric with goats.

However, this brings us to the second point of the dilemma. Goats may not be historic *natives* to Yellowstone, however, based on fossils from the Palisades, Idaho area, they were Pleistocene residents of the Greater Yellowstone Ecosystem approximately 30,000-70,000 years B.P. No more recent evidence of goats has been found in the area, but as little as 10,000 B.P., goats extended south to Mexico and east to central Wyoming (Mead 1983) with the proposed dispersal route being through the Yellowstone area (Mead 1983). The more southern prehistoric populations are designated as a separate species, *Oreamnos harringtoni*, Harrington's mountain goat. However, the specimens from central Wyoming are classified as the same species that is currently native to areas a few kilometers from the Greater Yellowstone Ecosystem.

All this clouds the issue of whether goats truly are native to the Yellowstone Ecosystem. However, the question still remains: what will be the impact of mountain goats on the current fauna and flora of Yellowstone NP if and when goats become established, or re-established. To determine their impact, I perused existing data to use in developing an environmental assessment of goats of the Greater Yellowstone Ecosystem. There were two major emphases. First, I tried to determine the potential number of goats we can expect to inhabit the park. This is a critical point because it could determine the impact goats would have on park vegetation. Workers in Olympic NP found it wasn't so much that goats were selectively eating rare plants but that the sheer numbers of animals increased their impact



on *all* plants, including the rare and endemic ones. They also found the wallowing behavior of goats, exacerbated by their numbers, caused extensive plant destruction and soil erosion. All these impacts would have been less severe if goat numbers had not become so high – 14 goats/km2 (Stevens 1983).

Goat densities vary from area to area. The lowest density of goats I found reported in the literature was 0.2/km2 in British Columbia (Herbert and Turnbull 1977) and the highest was 15.4/km2 in Glacier NP (Singer and Doherty 1985). Swenson (1985) found a density of approximately 0.4 goats per km2 in the mountains just north of Yellowstone NP. This is near the lowest estimate reported, so I used this density to estimate a low population level.

Based on the range of densities reported for areas similar to Yellowstone, I came up with a high estimate of 1.9/km2. The next step was to determine, a *priori*, how much goat habitat might exist in the park. As an estimate, I used the amount of current bighorn sheep habitat, 250 km2. Based on these figures, I estimated a low population of 95 and a high of 475 goats.

At the low density of goats, no major impact on park vegetation is expected. It is uncertain what impact the goats might have at the higher density. To determine the impact of higher densities of goats, I visited Glacier NP. In the area near Logan Pass, where goats are at a density of approximately 2.8 goats/km2 (Chadwick 1974), no measurements were taken, but no obvious signs of overgrazing or erosion from wallowing were evident. So, at the projected high density of goats for Yellowstone, no major impact of goats on the vegetation is expected. This is in contrast to what has happened at Olympic NP. Perhaps the higher density of goats at Olympic, their greater wallowing because of the warmer climate, and the intensification of these factors by high amounts of rainfall, all contributed to the goats' negative impacts there.

The second emphasis of my work was to determine the potential impact of goats, regardless of their numbers, on their nearest ecological relative, bighorn sheep *(Ovis canadensis)*. Bighorns traditionally have been considered the symbols of Yellowstone wilderness. Unlike other ungulates such as elk, deer, or bison, sheep live in the high elevations and rarely are seen by the casual visitor. To see a sheep means either that you had the fortitude to hike to their haunts or that you are extremely lucky. To lose this charismatic species would diminish the park's wilderness value.

To determine the potential impact of mountain goats on sheep, I estimated how much their food and habitat requirements overlapped by using existing data to calculate resource overlap indices (Lawlor 1970). Based on data from unrelated studies for general food categories (grass, forbs, and shrubs), goats and sheep diets would seem to overlap extensively (Fig. 1a). Even separation of diets into more specific categories would lead to the same conclusion (Fig. 1a).

However, comparison of diets from independent

(Continued on page 9)

Woodland Caribou Studied

Wildlife Biologist Jean Cochrane has been investigating for the last year and a half the feasibility of restoring caribou to their historic home on Isle Royale. Caribou and Canada lynx roamed the island archipelago for thousands of years, long before moose or wolves colonized the park after 1900. Caribou disappeared in the late 1920s, following a century of regional decline line due to overhunting, increased predation, and brainworm disease.

Prospects for caribou restoration are improved by the current decline in wolf numbers. Wolf predation would likely limit a caribou population to 20-50 animals dependent on secure "escape habitat."

A rare plant survey in 1992 will assess the potential impacts of caribou on Isle Royale's unique rock shore plant communities.

Peregrine Falcon Releases End

1991 will mark the fifth and last year for peregrine falcon releases on Isle Royale. Thirty-eight young falcons have been hacked from two sites in the park since 1987; 12 more will be released this year. While no birds have yet returned to nest, two birds have returned briefly and one has taken residence in Milwaukee, where she nested and raised young three years in a row.

A pair of hacked peregrines is nesting this spring in Michigan's Keweenaw Peninsula near the park's mainland headquarters, but biologists and birders have not yet been able to see the band numbers to determine whether they are Isle Royale birds. Falcons also will be released this year, for the second year, at Pictured Rocks National Lakeshore.

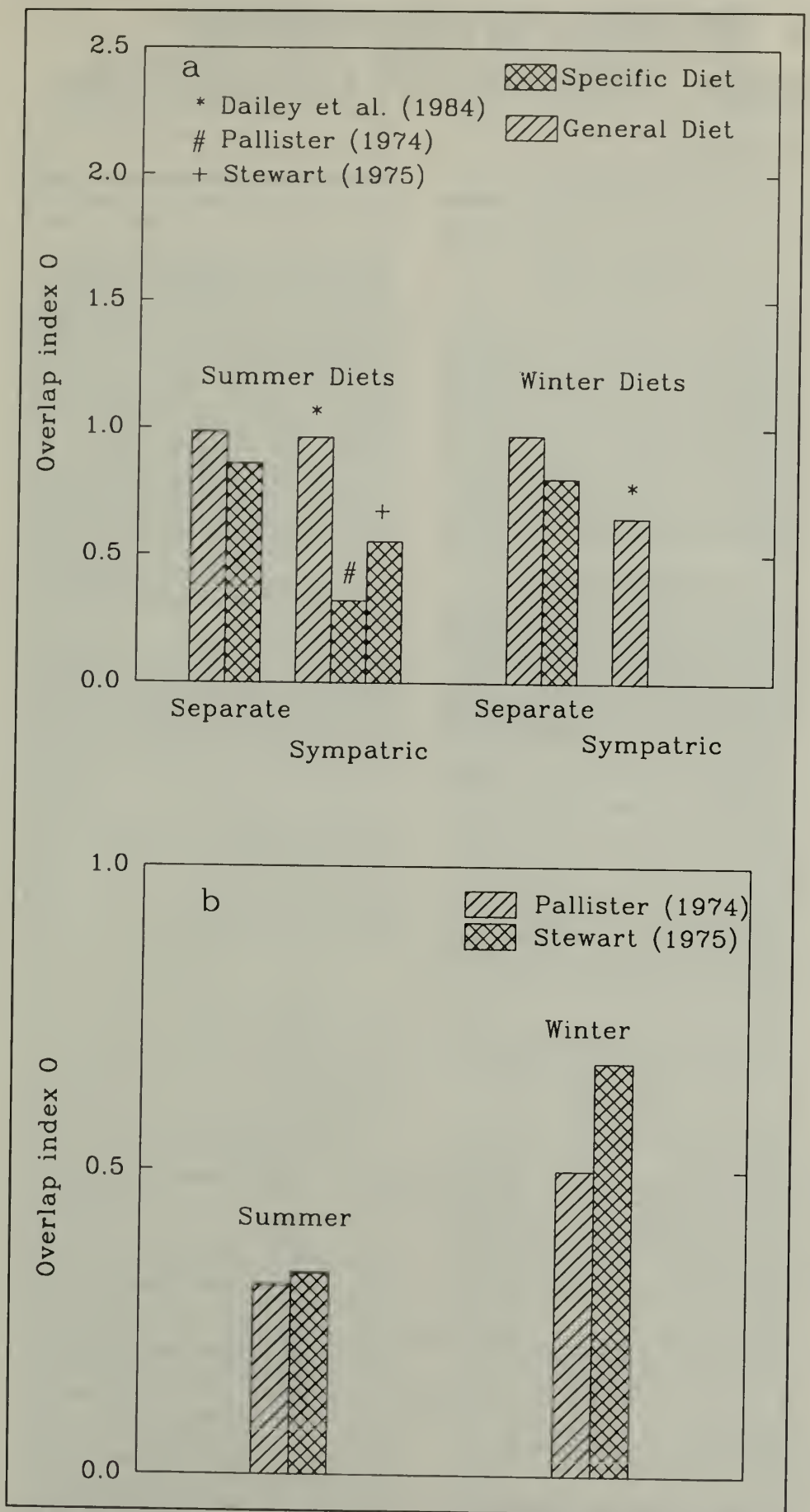


Figure 1. Niche overlap indices for food habits (a) and selection (b). Overlap indices for food are for pooled data from separate studies and data from comparative studies and are based on either general (grass, forbs, shrubs) or specific (to genera) food classifications. Indices for habitat selection are all from two comparative studies of sympatric sheep and goat populations.

studies present problems relative to food availability and presence or absence of competitors. The best way to determine the amount of actual overlap between goats and sheep is to compare diets of sympatric populations. Three investigators have done this. Dailey et al. (1984) compared general diets (grass, forbs, and shrubs) of sympatric goats and sheep in Colorado. Based on their data, the resource overlap index for summer diets was similar to unrelated studies (Fig. 1a). However, during the winter, resource overlap reduced substantially (Fig. 1a). Pallister (1974) and Stewart (1975) compared specific plant species used by goats and sheep in the Beartooth mountains just north of Yellowstone. Based on their data, the resource overlap indices were only half of what separate unrelated studies indicated (Fig. 1a).

Relative to habitat requirements, the only reliable comparisons that can be made are from studies of sympatric populations. Again, data from Pallister (1974) and Stewart (1975) indicated substantial habitat separation (Fig. 1b). It is important to note that the studies by Dailey et al. (1984), Pallister (1974), and Stewart (1975), were of "exotic" goats that had been transplanted into native sheep range. Thus goats and sheep are seemingly able to coexist, even when goats are "non*native" introductions, and goats will likely not exclude sheep from Yellowstone NP. Whether goats will significantly reduce sheep numbers is unknown at this time and will depend on which population level scenario proves accurate.

So, in conclusion, whether goats are to be considered exotics or prehistoric natives is a decision to be made by NPS personnel, luckily! If left uncontrolled, goats will continue to colonize Yellowstone NP and will reach a population of between 100 and 500 animals. The potential impact of mountain goats on Yellowstone flora is estimated to be not as severe as it was in Olympic NP. The presence of goats in the park also is not expected to affect adversely the continued survival of bighorn sheep. Some changes, however, likely will occur as Yellowstone adjusts to the return of one of its prehistoric residents.

Laundré is an Adjunct Professor in the Department of Biological Sciences at Idaho State University, Pocatello.

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Cape Cod's Atlantic White Cedar: Managing a Unique, Natural (?) Community

By Glenn Motzkin and William A. Patterson III

Cape Cod National Seashore (CCNS) contains the only NPS administered Atlantic white cedar (AWC; *Chamaecyparis thyoides*) wetlands (NPS internal documents). Although AWC occurs in four locations at CCNS, the 5-hectare Marconi Atlantic White Cedar Swamp (MAWCS) is the largest and most significant site, containing one of the few examples of an old-growth AWC stand in the northeastern United States. Management of the MAWCS poses unique challenges because the Swamp lies in a rapidly developing landscape that is substantially altered from its presettlement condition.

Atlantic white cedar is an early successional species that requires some form of disturbance to become established. In the absence of disturbance, it is thought to be replaced by more tolerant hardwood species (Buell and Cain, 1943; Little, 1950). The MAWCS is currently protected from fire and timber cutting and therefore is potentially threatened by these successional trends. We investigated both modern and prehistoric vegetation and disturbance patterns at MAWCS to determine the processes that have controlled vegetation development over the past thousand years. In this paper we present the results of this investigation and discuss management alternatives in the context of NPS objectives and cultural constraints.

Cedar first arrived at the Marconi site approximately 3000 years ago and has persisted in varying abundance since (Belling, 1977). Fine-resolution pollen and charcoal analyses of peat representing the last 1000 years of the Swamp's history indicate that fires, many of which probably were set by Indians (Patterson and Sassaman, 1988), were frequent in and around the Marconi site in the centuries prior to European settlement (Figure 1). Most fires probably ignited in the highly flammable oak-pitch pine forests on the upland and burned as intense surface or crown fires until they entered the Swamp. Cedar pollen percentages during this period appear closely linked to fire occurrence, suggesting that fires burned through the Swamp destroying existing cedar stands and regenerating new ones.

Past Fire Frequency Higher

Periods of dense shrub, herb, and moss cover, as evidenced by high pollen percentages for these taxa, suggest that open cedar stands unlike the one encountered today regenerated after presettlement fires. When increasing cedar pollen percentages indicated closing canopies, fires burned through the Swamp and initiated a new cycle of cedar regeneration. At no time in the several hundred years prior to European settlement did cedar pollen percentages reach the sustained levels (80-90%) that are evident since settlement.

Significantly, the high post-settlement percentages of cedar pollen are accompanied by low charcoal values, suggesting that few if any fires have burned in the Swamp since the time the surrounding uplands were settled (about 1650 A.D.). Higher fire frequency prior to European settlement apparently prevented the development of mature, dense cedar stands at MAWCS, whereas a lack of fire since settlement has allowed the current mature stand to develop.

Plots that we sampled within the MAWCS currently are dominated by cedar, with ratios of cedar to red maple basal area typically exceeding 4 to 1. Age-structure analyses of the modern vegetation indicate that AWC and red maple both occur in distinct age cohorts, with establishment of both species limited to episodes of recruitment associated with timber harvesting (Motzkin, 1990).

Most of the Swamp is dominated by a 100- to 150-year-old cedar stand, with red maple stems scattered throughout. In portions of this stand, little or no establishment of tree stems has occurred in the last 80 to 90 years. Elsewhere, light selective cutting 10 to 50 years

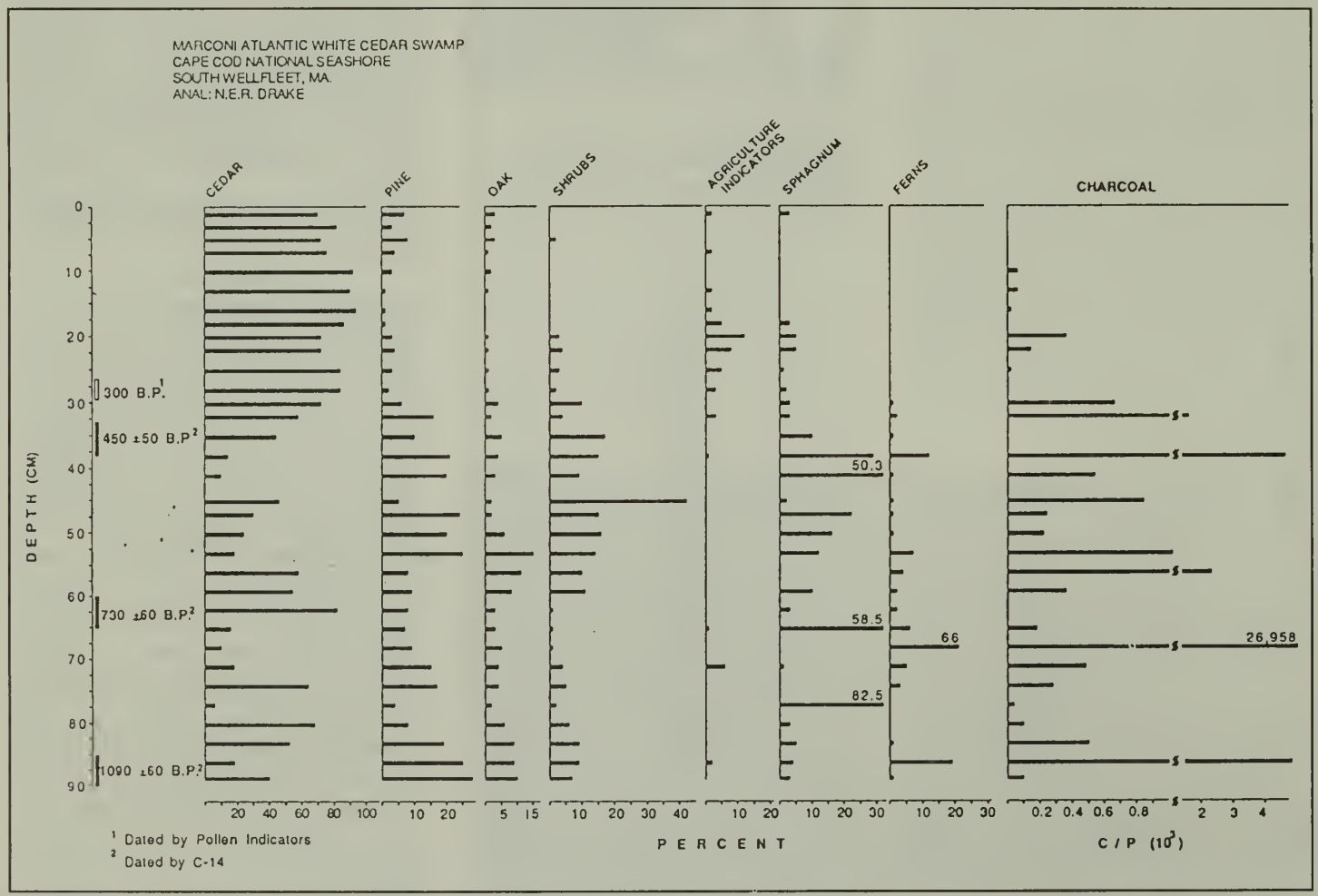


Figure 1. Pollen and Charcoal profiles for the Marconi Atlantic White Cedar Swamp, Cape Cod National Seashore.

How Does One Maintain An Early Successional Species?

prior to establishment of CCNS (in 1962) allowed cedar and, especially red maple, to regenerate. A few small, dense stands of young and intermediate aged cedar regenerated after more intensive cuts. In none of our plots did cedar or red maple continuously establish to form all-aged populations.

Disturbance-dependent Recruitment

Results of our investigation of both current and past vegetation indicate that disturbance factors have strongly influenced vegetation patterns at MAWCS. Establishment of cedar and maple occurs during distinct episodes of recruitment associated with disturbance events. In the past 80 years, timber cutting has been the primary factor influencing regeneration, with light thinnings favoring red maple and more intensive cutting favoring cedar. Prior to 1650 A.D., fires destroyed existing cedar stands but allowed for subsequent cedar regeneration. Fire frequency prior to settlement apparently was high enough to prevent development of dense stands of mature cedar like the one that currently occupies the site.

In the absence of disturbance it is unlikely that significant amounts of cedar or maple will regenerate beneath the existing mature stand. As this stand ages and canopy gaps are created by death of individual trees, portions of the stand lacking young maple or cedar but with abundant shrubs probably will experience increases in shrub cover. Subsequent regeneration of either cedar or maple at these shrub-dominated sites probably will depend on gap size and local site conditions.

Because light thinnings in the past favored establishment of maple over cedar throughout much of the Swamp, maples may increase gradually in importance relative to cedar as the existing stand breaks up. Cedars are likely to outlive red maples, however (Fowells, 1965), so cedar may again increase in importance as the young stems of both species age and maples die at a younger age.

A Future of Dense Shrubs

Such a scenario eventually would lead to a Swamp dominated by scattered old cedar above a dense stand of shrubs. Although cedar dominance may be greatly reduced in the Swamp as a whole, the presence of several small, 30- to 70-year-old stands suggest it is unlikely that cedar will be completely extirpated from the Marconi site within the next few centuries.

NPS management policies (NPS, 1988, p 4:2) note the importance of change as "an integral part of the functioning of natural systems," stressing also that "ecological processes altered in the past by human activities may need to be abetted to maintain the closest approximation of the natural ecosystem where a truly natural system is no longer attainable." Current Seashore policies of wildfire suppression and preservation of existing plant communities rule out fire and timber cutting as factors likely to influence future vegetation development in MAWCS. Because outer Cape Cod is now densely populated and highly developed, recreation of the pre-settlement disturbance regime of frequent, catastrophic fires would be impractical. The NPS might, however, adopt one of several management practices for this site, recognizing that none of them will duplicate pre-settlement conditions.

If current protection is continued, there probably will be a reduction in the importance of AWC relative to red maple and shrubs in the next century. The dense, old-growth character of the present mature stand will disappear. If NPS chooses to maintain a cedar-dominated stand at MAWCS, human intervention probably will be required. As the existing stand breaks up, small clearcuts could be established to regenerate dense, young stands of cedar (Roman et al, in press).

Management Options

In evaluating management options, the cultural and ecological value of maintaining a cedar-dominated stand should be considered. The Marconi Atlantic White Cedar Swamp is valued as one of the best remaining examples of the Coastal AWC vegetation type on Cape Cod. With good public access provided by a raised boardwalk, the Swamp is visited annually by many who appreciate its aesthetic qualities, including the dense, old-growth aspect of the cedar-dominated vegetation. Our results suggest that this stand is, in fact, unlike that which existed prior to settlement, and that, in the absence of disturbance, its long-term maintenance is in doubt. This site thus presents the interesting paradox of a highly valued resource that is in one sense "unnatural" while at the same time difficult to maintain in its present condition.

We have demonstrated that cedar is not immediately threatened by a management strategy that favors protection over active management. In fact, cedar trees probably will survive for a very long time at Marconi, but in a community that is different in structure, species abundances, and ecosystem processes than the one existing at the site prior to European settlement.

A similar conclusion may apply to many natural areas preserved for the unique species or communities they contain. Management of these areas must take into consideration not only current vegetation dynamics, but those of prior communities occupying the site as well. However, complex ecological processes and modern constraints to management may limit our ability to achieve the objective of maintaining a "close approximation of natural ecosystem processes."

Patterson is a professor and Motzkin is a Departmental Assistant with the U/MA Department of Forestry and Wildlife Management.

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letters

To the Editor:

This is with reference to "A Commentary on Visitor Statistics" (***Park Science***, Spring 1991, p. 17).

I did not expect to read an ode to killing under the above title. Surely Mr. Lovaas, as a Regional Chief Scientist, is far from needing the flesh of pristine wildlife to feed himself, no matter how tender the flesh of the creatures he kills.

Did it ever enter his mind that reveling in "being alive," flexing his muscles, etc., might have been equally enjoyed by the "fine bull moose" he killed? Not only does he verbally exult over what he destroys, he vicariously exults over what he might have killed – "a gorgeous, rolicking grizzly bear."

Such sentiments are philosophically out of context for the National Park Service. Such self-congratulatory prose and policies cause the public to question whose hands the fate of our wildlife is in, as they are increasingly doing with the so-called National Wildlife Refuge System.

Sincerely,
Mary Kelly Black
Park Service Employee

Al Lovaas Replies

Hunting is not philosophically out of context for the National Park Service, at least not on millions of acres where it is legally mandated. Ms. Black aims her anti-hunting sentiments at the wrong target; I don't make the rules.

Ms. Black obviously cares deeply for wildlife and I am disturbed she apparently believes I do not. I was trying to convey my respect, admiration, and love for wildlife and its habitat, to which I have devoted a long career, and I regret I was unable to express those feelings adequately.

Taking wildlife for food only deepens my respect. During every meal of moose flesh my thoughts return to the wild spirit of the animal I killed and of the wilderness which nurtured it. The previous year I contemplated similarly the deer I had killed in the old growth forests of the Tongass near Sitka. To tell the truth, however, I was never really sure just which of the six was represented on the platter at any particular meal. (The season bag limit was reduced to five in 1990 and four in 1991 because the population decreased after two tough winters and overbrowsed range).

As for the National Wildlife Refuge System, it was initiated in 1903 by President Theodore Roosevelt, a mighty hunter.

'Partners' Workshop

A workshop entitled "Partners for Research and Resource Management was presented to the NPS Resource Management Trainees class in Denver on March 11 by Dr. Sarah G. Bishop, President of Partners in Parks.

Dr. Bishop and the NPS Training Division are preparing a training package on the subject of building partnerships. It will consist of a reference manual and guidelines for presenting the information in a workshop or training course. Class evaluation of the course will be incorporated into the final version of the reference manual, which will be completed by June 1991.

The work of Dr. Bishop's organization is to find opportunities for individuals and organizations to assist National Park research and management programs through ongoing partnerships.

regional highlights

Western Region

Christine Schonewald-Cox, research scientist with the NPS/CPSU at U/Cal/Davis, has the following articles in press: "Cross-boundary Management Between National Parks and Surrounding Lands: A Review and Discussion," (with Marybeth Buechner and Raymond Sauvajot of the U/Cal/Davis Institute of Ecology and Bruce Wilcox of the Institute for Sustainable Development, 3000 Sandhill Rd., Bldg. 1, Suite 102, Menlo Park, CA 94025) in ***Environmental Management***; "Scale, Variable Density, and Conservation Planning for Mammalian Carnivores," (with Rahman Azari of the U/Cal/Davis Division of Statistics and Stephanie Blume of the NPS/CPSU at U/Cal/Davis) in ***Conservation Biology***; and "Park Protection and Public Roads," with Buechner in ***Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management***, 1991. Chapman Hall, NY, NY; editors Peggy Fiedler and S.K. Jain.

Recent publications already in print, and her co-authors, include "The role of interagency cooperation in managing for viable populations," with Hal Salwasser of the USDA Forest Service, and Richard Baker of the U/Cal/Davis Dept. of Environmental Studies, in ***Viable Populations for Conservation***, 1989. Cambridge Univ. Press, edited by Michael Soule'; "Biological Diversity and Global Change: Habitat Fragmentation and Extinction," with Thomas J. Stohlgren of the NPS/CPSU at U/Cal/Davis, in ***Proceedings of the Second US-USSR Symposium on Air Pollution Effects on Vegetation Including Forest Ecosystems***, USDA Forest Service, Northeastern Forest Experiment Station, Broomall, PA, 1990; "Wilderness and the Protection of Genetic Diversity," with Thomas Stohlgren of the NPS/CPSU at U/Cal/Davis, in ***Wilderness Benchmark 1988: Proceedings of the National Wilderness Colloquium***; USDA Forest Service Southeastern Forest Experiment Station Gen. Tech. Report, SE-51. Asheville, NC, 1989; and "Boundaries in the Protection of Nature Reserves," in ***BioScience***, Vol. 38 No. 7, pp 480-486.

* * *

From Mark Sogge, Biological Technician at the recently established CPSU at Northern Arizona University in Flagstaff, come the following two items:

A pair of endangered Peregrine falcons nested last summer along the border of Walnut Canyon National Monument. Tom Ferrell, District Ranger, suspected nesting activity on a cliff near the monument's border with Coconino NF. Mark Sogge verified the presence of two adult and two immature Peregrines at the cliff site in August. Biologists with the AZ Dept. of Game and Fish later rappelled from the cliff to the nest site and found Peregrine eggshell fragments and prey remains (scrub jays and nighthawks). This cliff is the smallest in the state to support nesting Peregrines, and reflects the positive status of Peregrine populations in Arizona.

* * *

Charles van Riper III and Mark Sogge of the CPSU at Northern Arizona State U, Flagstaff (CPSU/NAU), have conducted a series of meetings with the AZ Dept. of Game and Fish (ADGF) to initiate a cooperative study of Pronghorn on state and NPS land in northeastern Arizona. Petrified Forest NP and Wupatki National Monument have been selected as study areas. ADGF has studied Pronghorn population biology in the past, but research on NPS lands can contribute information not available elsewhere, such as the effects (at Petrified Forest) that paved roadways without associated cattle fencing have on Pronghorn movements. At Wupatki, researchers can study Pronghorn reproduction and mortality in grassland areas that are not grazed by cattle.

* * *

Elena Fraire, a Biological Technician at CPSU/NAU spent nine weeks in 12 of the 20 NPs and Monuments in Arizona. She gathered information on the natural resource databases in Casa Grande Ruins NM, Coronado N Mem., Fort Bowie NHS, Grand Canyon NP, Montezuma Castle NM, Organ Pipe Cactus NM, Petrified Forest NP, Saguaro NM, Tonto NM, Tuzigoot NM, and Walnut Canyon NM – all as part of Phase I of the Western Region Inventory and Monitoring Project headed by Tom Stohlgren, ecologist with the CPSU at U/CA/Davis.

She met with Superintendents and worked with Resource Management staff at each NPS unit. As anticipated, many of the parks lack baseline data for mammals, plants, reptiles and amphibians. In smaller parks, only checklists are available, many of which have not been updated since the early 1970s.

The CPSU/NAU will respond to the CPSU/UC/Davis findings by focusing baseline projects in the Colorado Plateau parks. The CPSU/NAU will enter data for a computerized bird list for the Grand Canyon NP based on the data structure set-up by the CPSU at UC/Davis. The CPSU/NAU will produce a computerized plant list for Montezuma Castle NM and Tuzigoot NM based on past studies. Ultimately, all these databases will be tied to a GIS that will be housed at the CPSU/NAU.

* * *

The CPSU/NAU is hosting the First Biennial Conference on Research in Colorado Plateau National Parks July 22-25 on the NAU campus in Flagstaff. Topics will cover but are not limited to air and water resources, grazing impacts, endangered species, introduced or alien species biology and control, inventory and monitoring, single species ecology, GIS, human impacts, climate and climate change, archeology, and riparian resources. Portions of the proceedings may be published.

* * *

Julie Pickering is the editor of a new quarterly newsletter for research and resource management of Colorado Plateau National Parks, titled ***Colorado Plateau***. The second issue (Spring 1991) features bald eagle research downstream on the Colorado river from Glen Canyon Dam and the effects of rainbow trout introduction on eagle populations. The increased numbers of bald eagles seen in winter months since the large winter spawning runs of trout became a factor raises a question of the importance of the non-native trout as a food source for the endangered bald eagle. It also highlights the management dilemmas that arise when established management goals seemingly conflict ... in this case, the welfare of an endangered species appears to be dependent on continuation of an altered ecosystem.

Pacific Northwest

The U.S. Forest Service formally unveiled on Feb. 25, 1991, the results of a two-year mapping project, showing that 4.3 million acres of old-growth trees remain on national forests west of the Oregon and Washington Cascade crests and in northern California. The Wilderness Society simultaneously released its own maps showing 3.8 million acres of "ancient forest" remaining on a similar but not identical land base.

Jean Durning, Seattle director for The Wilderness Society, called the ability to look at various old-growth types across the landscape the most useful outcome of the mapping program. "The big story comes," she said, "when you look at the maps themselves and look at what's on the ground. I think there are very important reasons to differentiate the vegetation types. Mountain hemlock is not interchangeable with ancient forest or spotted owl habitat."

The two studies used computer analysis of satellite imagery but employed different definitions of old growth and slightly different land bases in arriving at their numbers. The project identified 607,000 acres of old-growth forest in the Mount Rainier, Olympic, and Crater Lake NPs.

Rocky Mountain Region

A small population of the rare orchid *Spiranthes diluvialis* is the object of current research underway at Dinosaur National Monument in Colorado. NPS Water Resources Division hydrologists Bill Jackson and Joel Wagner, who participated in a multidisciplinary assessment of the Hog Canyon riparian system in the Monument, found that the alluvial fan at the mouth of Hog Canyon has been subjected to a variety of impacts including overgrazing and stream channel excavation/relocation. The rare orchid persists along a perennial, spring-fed stream, and research is attempting to determine how best to enhance its habitat.

Steve Petersburg, the Monument's natural resource management specialist, is conducting an evaluation of current hydrologic, geomorphic, and vegetation conditions, preparatory to developing ways of restoring pre-settlement hydrologic/geomorphic processes and vegetation communities. The work is being done along with an overall botanical survey, in cooperation with the USFS and the U.S. Soil Conservation Service.

* * *

A new program, established in the Region in 1990 to provide funding for natural resource mitigation, preservation and restoration projects, was made possible through increases in the regional base. Over 30 parks competed for FY 91 support, resulting in 17 new projects. They ranged from restoration of natural air flows at Wind Cave NP to the design and construction of watergates to prevent escapes of bison and elk at Theodore Roosevelt NP. The program is helping implement projects that often are too small or non-controversial to be funded through other regional or servicewide programs, especially at parks with limited base funding.

* * *

Impending development outside the Great Sand Dunes National Monument has created an urgent need for better understanding of the Dunes. Several research projects are underway to determine the impacts on park resources from outside development: Dunes coring, (by Adams State College); dating of the quartz sand in the dunes, (by the USGS); location of faults and mapping of surface and subsurface geologic structure, (by the Colorado School of Mines Geophysics Field School); loss of Medano Creek surface flow study, (by Utah State University); dunes vegetation, (by the USFS Shrub Sciences Lab in Provo, Utah); dunes insects, (by the University of Colorado); and sand migration. Once collected, the information will be put in GIS format to provide a tool for understanding and managing the complex dune system.

regional highlights (cont'd)

Yellowstone NP had begun a test of 25 bison for the *Brucella* organism, to determine the potential for infectivity. Blood and tissue samples from bison in the Mary Mountain herd were to be tested for the relationship between brucellosis serological positivity and actual infectivity in the Yellowstone sample tested. The project began April 8, 1991, when three bison were dispatched before a temporary restraining order was issue to halt the research due to litigation filed in Federal court by the Fund for Animals. This delay caused the NPS to miss the optimal period for conducting the research and the proposal was therefore withdrawn.

The park needs this scientific data for preparation of a long-term bison management plan. Yellowstone and the Regional Office are reviewing options to continue this research at a later date, taking into account alternatives for data collection, biological factors, public concern, visitor safety, logistics, protection of park resources, and possible legal challenges.

Midwest Region

Students in a U/WI graduate seminar on Ecology in National Parks conducted research on such topics as dynamics of toxic chemicals in food webs of boreal parks, reintroduction of wolves in Yellowstone, and exotic vertebrate invasions in South Florida parks. The spring semester course began with presentations by Walter Loope (Pictured Rocks National Lakeshore), Ron Hiebert (Chief Scientist for the NPS Midwest Region), and James Bennett (Great Lakes Cooperative Park Studies Unit).

• • •

Researchers and Resource Management Branch personnel of Indiana Dunes National Lakeshore are using the park's GIS to determine the frequency of wildfires occurring in a given area of the lakeshore and to document areas subject to a large number of wildfires. The information from the analyses will be used to defend various aspects of the lakeshore's fire management plan, now being revised, and to better manage lakeshore resources through proper application of prescribed fire.

• • •

Apostle Islands NL held its 12th annual research conference in Bayfield, WI on Oct. 24-25, 1990, providing an annual update on research at the Lakeshore. Presenters related their work to management issues posed by Lakeshore managers. Topics ranged from submerged cultural resources, sea kayakers, and spit geomorphology to black bears, eagles, and data management. Some 56 scientists, park managers, and interested public attended.

Southeast Region

A barred owl sitting on a pine limb in Congaree Swamp National Monument (NM) is the subject of the South Carolina Wildlife Federation print of the year. The Monument was chosen for the painting because the barred owl is found in the state's wooded swamps, river bottoms, and wetlands. The Federation is working in South Carolina to promote wetland conservation and policies that will protect wetlands. Congaree Swamp NM will serve as a host site for the Federation to feature in 1991 during efforts to educate the public about the valuable functions wetlands provide for wildlife habitat, flood control, pollution reduction and ground water recharge.

A print of the painting by artist Jann Rattray Twork is available, unframed, for $50 from the SC Wildlife Federation, P.O. Box 61159, Columbia, SC 29260.



Out on a limb

Mid-Atlantic Region

Gary Machlis, Sociology Project leader at the U/ID NPS/CPSU; Dick Ring, superintendent at Delaware Water Gap NRA; and Jeff Marion, CPSU unit leader at Virginia Tech presented a social science plan developed by Machlis for the Delaware Water Gap to the Northeastern Recreation Research Conference. The plan reviewed previous social science research relevant to the Water Gap, evaluated and summarized needed research, and outlined a four-stage action plan for obtaining the needed research. Copies of the plan are available from Beth Johnson, Delaware Water Gap NRA, Star Route 38, Milford, PA 18337, (717) 296-6952. An article describing the plan is being prepared for ***Park Science***.

Also at the Northeastern Recreation Research Conference, Malcolm Ross, Resource Management Specialist at the Upper Delaware Scenic and Recreational River, presented a paper titled "Environmental Glasnost: Protecting a Resource You Do Not Own," describing the challenges faced by managers at the Upper Delaware in achieving agency objectives through work with local governments, state and federal agencies, and area residents.

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Shenandoah NP recently held a second meeting of its Science Advisory Board, at which board members reviewed the park's Long-term Ecological Monitoring program, a new Resource Management plan, and discussed prospects and application procedures for nominating the park as a new Biosphere Reserve. This year marks the third and final year of Peregrine falcon releases.

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The Mid-Atlantic Region welcomes new resource management staff and says farewell to some migrating friends. Welcome to Pat Lynch, GIS Program manager at Shenandoah NP; Keith High, GIS Specialist shared by Delaware Water Gap and the Upper Delaware Scenic and Recreational River, and John Perez, Resource Manager at Fredericksburg and Spotsylvania Battlefields. Farewell to Kathy Jope, Regional Resource manager, to the same position for the Pacific Northwest Region; Rick Potts, Shenandoah Resource manager to the same position at Katmai NP, and Meg Weesner, New River Gorge National River Resource manager to the same position at Saguaro National Monument.

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Delaware Water Gap NRA recently hosted a 25th Anniversary Symposium. Topics included natural science, public policy, park administrative history, and regional cultural history. Copies of the Symposium Proceedings are available from the Superintendent, Delaware Water Gap NRA, Bushkill, PA 18324.

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Jeff Marion, Virginia Tech CPSU unit leader, reports completion of a cooperative USFS/NPS study titled "Results from the Application of a Campsite Inventory and Impact Monitoring System in Eleven Wilderness Areas of the Jefferson National Forest." Significant improvements in impact assessment procedures, including a more accurate and precise Variable Radial Transect method for measuring campsite size, a comprehensive manual of monitoring protocols, and menu-driven dBASE IV databases also are featured in the report.

Marion is working on a servicewide I&M manual for managers seeking to develop recreation site impact monitoring systems. The Jefferson NF report is available from Marion at the NPS/CPSU, Virginia Tech, Dept. of Forestry, Blacksburg, VA 24061-0324 (703) 231-6603.

Wildlife and Vegetation Division

Three members of the Division participated in the International Conference on Science and the Management of Protected Areas held May 14-19, 1991 in Wolfville, Nova Scotia. Mike Ruggiero, on behalf of himself and co-authors Tom Stohlgren and Gary Waggoner, presented a paper, "Towards a Biological Survey of the US National Park System" to a session on Management Strategies. Nape Shelton gave a paper on "Removing Bottlenecks in the Transfer of Park Research Information" to a session on Putting Policy into Action. Pete Comanor, on behalf of himself and co-author John Dennis, presented a poster session and paper titled "US National Parks: Benchmark Contributors to Long-term Global Change Research" in a session on that subject.

• • •

NPS-77, the NPS's first comprehensive guideline on natural resources, has been completed and is in printing.

Alaska Region

The US-USSR Beringian Heritage International Park planning team met April 22 through May 6. The joint team toured northwest Alaska, Denali, and Kenai Fjords NPs, and conducted meetings at the Alaska Regional office and the Denver Service Center. Legislation is to be introduced on both sides in 1991. Targeted completion of the International Park is 1992.

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Reports published in the Region recently are:

Racine, C.H. and G.M. Ahlstrand. 1991. Thaw response of tussock-shrub tundra to experimental all-terrain vehicle disturbances in South-central Alaska. Arctic 44:31-37.

Wesser, S.D. 1991. The effects of light and moisture on two species from contiguous communities of south-facing bluffs in Interior Alaska, USA. Arctic and Alpine Research 23:99-103.

Three Australian scientists, after 20 months of research in the South Pacific, have confirmed a connection between plankton gas emissions and cloud-seeding sulfur compounds. While other correlations of the Gaia hypothesis remain unproved, the results, they suggest, lend weight to the idea that the planet and its life forms collectively constitute a self-regulating "superorganism."

Plankton are known to excrete a gas rich in sulfur compounds, and those compounds in turn create "cloud condensation nuclei" – the seeds of clouds. When the Earth's temperature rises, plankton growth increases, causing more gas emissions into the atmosphere and thus more clouds. The clouds block sunlight, reducing air temperature, restricting plankton, and thus maintaining planetary equilibrium. So goes the theory proposed two decades ago by British climatologist James Lovelock and U.S. biologist Lynn Margulis and named for the Greek goddess of Earth.

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Leslie Roberts, editor of the News and Comments section of ***Science***, devoted his section in the March 15, 1991 issue to discussing the fallout from the government's massive acid rain program. NAPAP (National Acid Precipitation Assessment Program) involved some 2000 scientists and half a billion dollars over a decade to create "an impressive body of scientific research," Roberts said, but in terms of policy, he quotes one congressional aide as calling it "totally irrelevant." Others have said that although NAPAP may have fallen short of its policy goals, its scientific research helped define the parameters of the debate early in the decade.

Roberts suggests that the program never really recovered after publishing a 1987 interim report "that was widely perceived as a biased attempt to downplay the problem – a sobering reminder of just how fragile credibility can be when dealing with such a highly emotional issue as acid rain. More than that, however" Roberts adds, "NAPAP strove for scientific perfection and lost policy relevance in the bargain."

"Scientific overkill?" asks the caption next to a picture of the five feet tall stack of 6000 pages – the final NAPAP report. James Mahoney, who directed the program, says that with the benefit of hindsight, he would have directed some of the resources away from NAPAP's enormously complicated atmospheric transport model toward "simpler models that could have provided answers sooner" and warned the interagency Committee on Earth and Environmental Sciences that "Global change is driven by too much raw science." The NAPA scenario, he indicated, is already repeating itself in the new federal climate change program.

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Paleontologists have identified the 135 million-year-old fossil remains of a bird from northeast China that documents an important step in the evolution of avian flight. Paul C. Sereno of the University of Chicago announced the find at the October 1990 meeting of the Society of Vertebrate Paleontology in Lawrence, KS. The still-unnamed sparrow-sized specimen is the earliest known example of a bird with modernized flying ability – about 10 to 15 million years "younger" than the oldest known bird, *Archeopteryx,* and shows several flight features that its crow-sized predecessor lacked. The fossil, described in ***Science News***, (138:16, p. 246) "shows an intriguing mix of modern avian features and primitive characteristics retained from reptilian ancestors." It had flight-specialized shoulders and a shortened set of tail vertebrae fused into one bone – an avian adaptation called the pygostyle. It also had claws that were long and curved, allowing better perching ability than its ancestors.

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Peter Olson, a geophysicist who conducts convection experiments in oil-filled tanks at Johns Hopkins University in Baltimore, likens a fresh cup of hot coffee into which a liquid creamer has been poured to the mantle of the planet Earth. Both the coffee and the mantle stir themselves by a process called convection. As heat escapes at the top of the mug, the upper layer of coffee cools and grows denser, sinking toward the bottom in sheets. The descending currents force warmer liquid to rise.

The earth's mantle warms mostly from within – some 80 percent of its heat coming from the decay of radioactive elements distributed throughout the mantle layer. "The remaining fraction of heat comes from the core below," according to Richard Monastersky in an offbeat little piece in the December 1, 1990 issue of ***Science News***. "At the top of the mantle, heat escapes upward through the tectonic plates that form a thin, broken shell encasing the mantle. These plates continuously rearrange their positions on the surface, bumping and grinding against each other with Earth-shaking consequences."

In the mug, after addition of the cream, you can witness a miniature imitation of the grand geophysical process – where sheets of cold ocean floor sink into the hot mantle, a process called subduction. Volcanoes grow over subduction zones because some of the oceanic rock melts as it plows down into the hot mantle, causing molten magma to rise and then erupt at the planet's surface.

"Of course, java is not lava," Monastersky admits, "and you can carry the mug/mantle analogy only so far. Given that geophysicists have difficulty simulating mantle and plate motion even with complex computer models costing a million dollars, how much can you expect from a 60-cent cup of coffee?"

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Park Science readers who were intrigued by Jim Wood's article, "Technical Writing As a Tool – an Art" (***Park Science*** 11:1, p. 13), might want to check out the piece by George D. Gopen and Judith A. Swan, "The Science of Scientific Writing," in ***American Scientist*** (Nov/Dec 1990, pp 550-558. The authors expand on the thesis that if the reader is to grasp what the writer means, the writer must understand what the reader needs. Gopen is director of writing programs at Duke University; Swan teaches scientific writing at Princeton.

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A startling botanical conversion, totally unexpected, is the dense blanket of knee-high grass that now stands where formerly patchworks of scraggly shrubs and parched earth existed in the Chihuahuan Desert. The transformation is the result of a study begun in 1977 by James H. Brown, an ecologist at U/NM in Albuquerque, to assess the ability of native kangaroo rats to compete with native ants for the area's supply of large plant seeds. It began with exclusion of these rats from small plots of shrubland in southeastern Arizona. Eight of the original 24 small plots (2500 square meters) were surrounded by fine-mesh fences, adjusted to exclude either all rodents or at least three species of the kangaroo rats native to the sites. The finding documents for the first time, according to R. Cowen writing in ***Science News***, Vol. 138, p. 391-392, "that the collective actions of several related types of animals – not just the behavior of a single species – can dramatically alter the fate of an ecosystem."

"People are only worried about the much more comprehensible and simple question of conservation – whether a species is there or not," comments marine ecologist James A. Estes of U/Cal/Santa Cruz. "But if an ecosystem is tied together by a guild rather than a single species, our emphasis ought to be on conservation of the guild rather than the species."

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"Is a warm-water cycle stripping corals of their lifeblood?" asks Robert N. Langreth in a ***Science News*** Dec. 8, 1990 article, "Bleached Reefs." Weeks of abnormally warm water have caused the usually colorful Puerto Rican corals to expel the algae that give them their hues. A former commercial fisherman who now assists marine botanists at the University of Puerto Rico in Lajas, says: "Some people say this is normal. I'm 42 and I've been working in the water all this time, and I've never seen something like this before."

Apparently, scientists have known about coral bleaching for at least 75 years, according to Langreth, but the phenomenon became widespread only in the last decade. The summer and fall of 1987 brought the world's most extensive bleaching on record. In past years, most of the faded reefs recovered during winter, but this year many researchers worry that corals, weakened by repeated bleachings, may actually die.

The issue has drawn the attention of the Senate Committee on Commerce, Science and Transportation. At an October 1990 subcommittee hearing, reef researchers ventured the disturbing prediction that the current coral fadeout may signify the beginning of the expected global greenhouse warming.

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Michael Glantz, a senior scientist at the National Center for Atmospheric Research in Boulder, CO, describes (in an article for ***Knight-Ridder News Service***) a new category of international refugee: environmental refugees ... people who have fled their homes to other parts of their country or across international borders because of environmental degradation and changes. Processes like desertification, deforestation, and prolonged droughts have caused them to seek a new homeland in order to feed their families," Glantz writes. "Like those fleeing from a local war (refugees) or in search of a better life (economic refugees), they too have no official status as refugees."

The UN Environmental Programme, Glantz reports, is concerned about this development, believing that future climate change will increase the numbers of such refugees by tens of millions. With no provisions for such a scenario, Glantz suggests that it is time for a new concept of refugee and for countries to "face up to their obligation to assist refugees in their moments of need."

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"Keeping anglers happy has a price," is the title of an article by Science Writer Billy Goodman in the May

1991 issue of ***BioScience***, pp. 294-299. Goodman recaps recent findings on the ecological and genetic effects of stocking fish – findings that again point out the fallacy of thinking of some consequences as "effects," and others as merely "side effects." Introduction of game fish has been found to have a variety of deleterious effects on local species. They may outcompete them, causing their extinction; they may hybridize with a rare local relative, imperiling the rarer species' genetic integrity; they may interbreed with local populations of the same stock and disrupt the local stock's adaptation to its environment.

The key to understanding what happens when hatchery fish are planted on top of wild fish, according to Richard Vincent of the Montana Department of Fish, Wildlife, and Parks, is to understand the different behavior patterns of wild and hatchery fish. Fish raised in a hatchery have lost their territorial behavior. Hatchery fish don't recognize territorial signals of the wild fish; the wild fish don't fight for the food as hatchery fish do – they simply move to other parts of the stream where cover or food may be poorer.

A sidebar box, with this article, describes the steps that Washington state hatchery managers are taking to minimize genetic impoverishment and domestication of captive-reared fish. Some hatcheries are using automatic feeders to reduce fish contact with humans, thus preserving the flight response of wild fish. They also are returning to the wild for new brood stock every several generations, thus infusing new genes into the hatchery population and breaking selection for domestication.

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An article in ***BioScience***, Vol. 40 No. 9, pp. 640-642, by Jill Baron and Kathleen A. Galvin, describes how ecosystem science can be used to address the myriad environmental problems. "Future Directions of Ecosystem Science" describes the growing awareness of global-scale environmental degradation and the three levels of environmental concern – local, regional, and global.

The questions inherent in this approach were tackled at a conference at Pingree Park, CO, in October 1988, by a workshop funded by the National Science Foundation and comprised of 40 prominent women scientists. The ***BioScience*** article addresses both the scientific issues and women's status in science.

"... there is more to becoming a successful professional scientist than university coursework and Ph.D. research," the group concluded. "Women must assertively seek out successful graduate experiences ... (and) must develop enough self-confidence and knowledge of their limits to be able to say 'no' when the demands become too great."

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Jill Baron, a research associate at the Natural Resource Ecology Lab, CO/State/U and a research ecologist with the NPS Water Resources Division, is co-author with Alisa Mast and James Drever of an article in the December 1990 issue of ***Water Resources Research***, titled "Chemical Weathering in the Loch Vale Watershed, Rocky Mountain NP." The article examines the source of solutes to surface waters draining the Loch Vale watershed in the Front Range of Colorado and concludes that the surface waters there are susceptible to acidification should acid deposition from the atmosphere increase.

notes from abroad

Editor's Note: David Parsons, Research Scientist at Sequoia/Kings Canyon NPs, represented the NPS Global Change Program Committee at an international workshop, "Earth system response to global change – northern and southern hemisphere contrasts," held in La Serena, Chile Nov. 30 to Dec. 4, 1991. The workshop was sponsored by the Chilean Academy of Sciences; the American Assn. for the Advancement of Science (USA); the Chilean, US, and Canadian IGBP (International Geosphere and Biosphere Program) Committees, and the McArthur Foundation. His report follows:

By David Parsons

The meeting brought together experts from such diverse fields as atmospheric science, oceanography, wildlife, vegetation, forestry, hydrology, biogeochemistry, and human geography to discuss the potential effects of global climate change on the west coasts of North and South America. Paired presentations were made on each of the above disciplines by leading scientists from each hemisphere.

The obvious similarities between Chile and the west coast of North America (located on the west coasts of continents, influenced by major oceanic current systems, similar climates, vegetation, and topography) provide many natural comparison bases. Differences in land use history and the ratio of land to ocean surface area in the two hemispheres lead to some differences in the projected impacts of increases in greenhouse gas concentrations on air temperature.

The Chilean scientists, with whom I was most impressed, and I identified many areas of potential collaboration between NPS sites in the western U.S. and sites in Chile. I was one of only two U.S. government representatives at the workshop, highlights of which follow.

The potential for using El Nino events as a surrogate for anticipated global warming was discussed. In 1968 and 1983 El Nino events (the two largest such in recent history) resulted in a 2 to 3 degree warming in the California Current and a shifting of currents to the north; thus shifting storm tracks as well. Unfortunately, the existing Global Circulation Models (GCMs) do not include ocean circulation patterns. There was much discussion as to whether increased CO2 might increase the frequency of anomalous events such as El Ninos, droughts, floods, etc. The shift in currents, ocean temperatures, biota (which will respond quickly), etc., might provide an interesting basis for work at Channel Islands NP or other west coastal sites.

Warming will not be uniform across the globe, and in fact, cooling might well occur in some areas. Faster and larger temperature responses can be expected over land than over the ocean and thus the relative amount of land and water will influence the rate of climatic response (e.g. temperature increase can be expected to be faster in the northern hemisphere where there is greater land mass). (Kevin Trenberth, INCAR, Boulder).

The best estimates show the global mean surface temperature has increased 0.5 C. over the past century. In the northern hemisphere this increase was largely before 1940. Decreases occurred in the 1960s and how a recovery to a new high point has occurred in the 1980s. (Trenberth).

Discussions of hydrology and projected increases in evapotranspiration demand on water identified the interior west and southwest of U.S. as most vulnerable to climate change. (Rick Lawford, National Hydrology Center, Canada).

The presentation on intertidal systems (Jan Lubchenco, Oregon State) was a particularly clear outline of the sensitivity of these highly productive and diverse systems to predicted changes in sea level, sea and air temperature, and nutrients. I was struck with many implications for NPS coastal areas. Lubchenco also suggested that research programs may need to focus on targeted species: species at risk, species important to the system, or species important to global processes. She suggested attention be directed at the edge of species distributions (especially the thermal limit), at long lived species, at species with short dispersal distances, at pathogens, and at multiple stresses and rare events. These suggestions may be important for other ecological systems as well. (Note: Lubchenco is the next president of the Ecological Society of America – a valuable contact.)

Discussion of the importance of modeling the impacts of global change emphasized the importance of clearly articulating the questions being asked and the need to include process models. Problems of scaling and disturbance were emphasized. (Carlos Prado, U/Catolica, Santiago).

Wide ranging discussions of vegetation and plant responses included paleoecological analogs, documented changes in treeline, life cycle characteristics, dispersal modes, genetic constraints, and human impacts. I see several potential areas for collaboration with the Sequoia/Kings Canyon program. (Sterling Keeley, Whittier College; Hal Mooney, Stanford; Mary Arroyo and Juan Armesto, Univ. de Chile; Carolina Villagran, U/Catolica).

An excellent model of what could happen to animal species subjected to temperature increases (no change, evolution in place, migration, or extinction) was presented by Jim Brown (U/New Mexico). He developed a specific example of the predicted extinction of small mammals on mountain tops in the Great Basin.

An evening discussion focused around the recent announcement of the U.S. government to support the concept of up to five regional research centers for global change, and that one of these should be located in Latin America. Despite obvious points in favor of Brazil for such a center, it was agreed that Chile could offer much as well, and that this would be pursued through appropriate channels. Discussion also focused on the value of developing a filter, or mechanism, to help determine what species, communities, and functional groups should be concentrated on for monitoring and process studies. A similar approach might be of great value to the NPS global change program.

Following the workshop, I met with faculty at both the Universidad de Chile (Drs. Arroyo and Juan Armesto and students) and the Catholic University (Dr. Eduardo Fuentes) regarding future collaboration. There was great interest in cooperation toward applying similar methodology to address questions of plant population biology, dispersal mechanisms, ecotone stress, climate and fire history, and developing comparable methods for long term monitoring.

I feel that my participation in the workshop was of value to the other participants, to the workshop products (which I helped write up), and to our global change program. The contacts made have potential for valuable spinoffs.

GIS Used to Develop Fire Management Strategies

By Carl Douhan, Randy Knutson
and Kenneth L. Cole

Researchers and resource management personnel at Indiana Dunes National Lakeshore (NL) are using the lakeshore's geographical information system (GIS) to determine wildfire frequency in given areas within the lakeshore. The information from the analyses will be used by lakeshore staff to refine the Fire Management Plan, currently being revised, and to better manage lakeshore resources through the proper application of prescribed fire.

A linear park located on the southernmost shore of Lake Michigan in urban Northwest Indiana, the lakeshore is the meeting place of the western prairie, northern boreal forest, and southeastern hardwoods and is noted for its biodiversity. The area has been heavily impacted by modern human activities. Transportation and utility corridors, drainage ditches, industry, and communities divide the lakeshore into isolated segments. Mining of sand, logging of timber, draining of wetlands, and suppression of wildfires have vastly altered the plant composition of the area.

Despite these impacts, Indiana Dunes has an unusually high plant diversity, currently third highest of any area in the National Park System, with 1,445 species of vascular plants (Pavlovic and Cole, In Press). It also possesses 29 percent of the state's threatened and endangered plant species (Bowles et al 1986).

The lakeshore experiences an average of 29 wildfires annually, all human caused, with the majority occurring in its western portion. Based on information from past fire reports, the fires were divided into spring and fall burns, and the perimeters of all fires for which accurate maps existed were digitized into the GIS data base. The staff was able to digitize approximately 90 percent of the reported wildfires that occurred between 1982 and 1989, and 100 percent of the wildfires occcurring after 1989. However, wildfires as large as 100 acres that occurred prior to 1989 were not entered into the data base because their mapping format could not be digitized. Although attempts were made to reconstruct the fire maps, in some cases too much time had elapsed for accurate reestablishment of the fire perimeters on appropriate maps.

The work has resulted in a reasonably complete digitized record of the wildfires in the lakeshore since 1982 and the data base will provide researchers and members of the Resource Management Branch with a highly credible statistical sample.

The data can be used in a variety of ways. For example, the annual occurrence and location of each reported wildfire, when combined with similar fire maps from other years, provides investigators with a much clearer picture of fire frequency for different park units. Over a period of time, these overlays can be used with a high degree of confidence to test statistical hypotheses. For instance, the staff has found that some areas of the lakeshore have burned at least six times between 1982 and 1990. This combined wildfire data was overlaid with a digital map of the fire-dependent vegetation types. When the two were compared, the lakeshore areas that experienced the highest frequency of burns closely matched the distribution of fire dependent plant species and community types.

The lakeshore is in the process of developing a new fire management plan and will use the various outputs derived from the GIS data base to recommend courses of action to management and to identify trends. These outputs, in a variety of combinations, will be used to determine the size and location of burn units, complete a fire prevention and risk analysis, identify and rank values at risk, verify fuel models, and recommend optimum burn frequencies for the different plant communities in the lakeshore.



***High flames penetrate** into a thicket of aspen sprouts in the wet prairie.*



***Igniters work around the perimeter** of prescribed burn area using drip torches.*

The lakeshore's Research Division has been conducting studies for the past eight years to determine historic fire frequencies and to develop an understanding of the effects of fire and other natural phenomenon on existing plant and animal communities. Based on these studies, the following premises have been developed concerning the effectiveness of fire as a management tool at the lakeshore:

– Oak savanna and prairie communities will best be maintained by a fire interval of from two to eight years, depending on the unit history, specific goals, and year-to-year climatic variations (Cole et al, 1990; Taylor, 1990; Henderson and Long, 1984).

– Annual fires are not recommended for either restoration or maintenance of oak savanna as these burns often have little fuel and may damage sensitive herbaceous species.

– Remnants of the oak savanna/prairie community must be burned at least every 15 years or they may be lost because of the increasing diameter of saplings (Cole and Klick, 1990) and the increase in canopy cover.

– Spring burns seem to be the most cost effective because the appropriate climate windows occur more predictably during this season.

– The fire dynamics of marshes and wet prairies are

(Continued on page 17)

Fire Strategies *(Cont'd)*

complicated by additional factors such as water table fluctuations and herbivores and are in need of further study.

The results of this research have formed the basis for future fire management activities at the lakeshore. Beginning in 1991, members of the resource management staff are using the data displayed on the combined burn frequency overlays to locate monitoring plots designed to document the effects of fire frequency on species composition and fuel loading, especially for fuel size distribution. Attempts also will be made to compare areas experiencing spring and fall burns.

Results of these studies will be used to validate the results of the research conducted thus far, including effects of fire on threatened and endangered plant species.

To date no attempt has been made to integrate burning conditions of past fires. However, starting in 1991, observed weather conditions at wildfires over five acres in size are being recorded. The observed conditions are being entered into BEHAVE, a fire effect program. The results will be used to categorize the severity of the burn to verify past output values from BEHAVE. A limited amount of pertinent information concerning each fire will be entered into a dBase file, which may be utilized by GIS.

Summary

The proper utilization of the GIS, when combined with research and monitoring activities, will greatly enhance the understanding of the effects of fire on plant and animal communities and provide researchers and managers with creditable data to make management decisions that will stand up to public scrutiny and peer review.

Douhan and Knutson, at the time of writing, were resource management specialists at Indiana Dunes NL. Knutson is still there in that capacity, while Douhan moved in May 1991 to the NPS National Capital Region as a fire management specialist. Cole is a research ecologist with the Indiana Dunes Research Division.

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Loon Survey Conducted

A 1990 loon survey on Isle Royale revealed the presence of 22 successfully nesting loon pairs, apparently saturating the inland lake habitat. Loon chick production on Lake Superior, however, was down approximately 62 percent from a 1985 survey. Lake levels are down and boaters are up in the five intervening years, making it impossible to tell whether or not the two data points signify a trend. The Lake Superior portion of the loon survey will be repeated in 1991 to give a third data point.

meetings of interest

1991

July 21-15, WORLD CONGRESS OF LANDSCAPE ECOLOGY, meets for the first time in North America, at Carleton College, Ottawa, Canada, featuring six symposia selected by an international panel of reviewers and addressing topics of current intellectual and practical significance. Contact: James F. Thorne, Dept. of Landscape Architecture, 119 Meyerson Hall, Philadelphia, PA 19104-6311; (215) 898-6591.

July 22-25, FIRST BIENNIAL CONFERENCE ON RESEARCH IN COLORADO PLATEAU NATIONAL PARKS, at the Northern Arizona University campus, Flagstaff. Contact, Charles van Riper III or Mark Sogge at the NPS/CPSU, P.O. Box 5614, NAU, Flagstaff, AZ 86011.

Aug. 16-25, DENDROECOLOGICAL FIELDWEEK, an 8-day program at the H.J. Andrews Experimental Forest near Blue River, OR, combining field research activities, lectures, and informal personal interaction. Recognized experts will lead small groups through exploring the usefulness of tree-ring analysis in multi-disciplinary research. Contact: Paul J. Krusic, P.O. Box 75, Nottingham, NH 03290.

Sept. 16-17, FIRST BIENNIAL SCIENTIFIC CONFERENCE ON THE GREATER YELLOWSTONE ECOSYSTEM: Theme, Plants and Their Environments; NPS host agency; at Mammoth Hot Springs Hotel, Yellowstone NP. Contact: Conference Committee, c/Research Division, P.O. Box 168, Yellowstone NP, WY 82190.

Oct. 7-10, OUR NATIONAL PARKS: CHALLENGES AND STRATEGIES FOR THE 21st CENTURY, a symposium on the occasion of the 75th anniversary of the National Park Service, in Vail, CO, exploring park issues and opportunities and charting future courses for management of the National Park System. Contact: NPS Employee Development Division-DSC, 12795 W. Alameda Pkwy, P.O. Box 25287, Denver, CO 80225-0287.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact: National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, Dc 20036.

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL – JOINING HANDS FOR QUALITY TOURISM, in Honolulu. For registration and travel/housing information, contact Ray Tabata, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2858.

Nov. 16, NEZ PERCE ART EXHIBITION, "Sapatqayn: 20th Century Nez Perce Artists," opens at the Nez Perce National Historical Park, Spalding, ID, featuring 50-100 pieces of traditional contemporary art, some never before seen by the public; with documentary catalog, guest speakers and demonstrations by Nez Perce artists. To run through Jan. 12, 1992. Contact: Nez Perce HNP, P.O. Box 93, Spalding, ID 83551; (208) 843-2261.

1992

Feb. 19-22, SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme: "Social Aspects of the Wildland/Urban Interface," at the Clarion Hotel, Ontario, CA. Contact: Debbie Chavez, USDA Forest Service, 4955 Canyon Crest Dr., Riverside, CA 92507.

May 17-20, FOURTH NORTH AMERICAN SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, in Madison, WI. Contact: Donald R. Field, 1450 Linden Dr., Madison, WI 53706.

Agricultural Pest Scouting Tried

This summer the agricultural program at Cuyahoga Valley NRA will attempt to use the State of Ohio Agricultural pest scouting program as a means of applying integrated pest management principles to crops of sweet corn, field corn, and soybeans.

The park's technical assistance preservation staff (TAPS) oversees the agricultural field leasing program. The Midwest Region Natural Resources Division is funding a contract between Cuyahoga Valley NRA and county extension agents to monitor agricultural fields and write "prescriptions" for the application of herbicides. The prescriptions are based on distribution of weed seedlings and the economic impact forecasted by the weed crop, and will trigger the pesticide use approval form (10-21A). The prescriptions are a method of quantifying this year's post- emergent weed crop to aid in this season's herbicide treatment or next year's crop rotation. It is hope that this scouting program will develop and eventually be worked into the fair market value of agricultural leases at the park.

Bald Eagle Studies

Apostle Islands NL is conducting a cooperative pilot study on bald eagles with the Wisconsin Dept. of Natural Resources and the USFWS. Productivity of bald eagles along the Lake Superior shoreline is less than that of birds on the mainland. Levels of organochlorine pesticides are elevated in Lake Superior eagles and have been hypothesized to be the cause of reproductive impairment. However other factors such as climate conditions and food availability have not been well studied. Turnover rate also has not been documented but is suspected to be high.

This pilot study will set a framework for determining the cause(s) of lowered productivity in Lakeshore eagles. Direct observations of Lakeshore and mainland nests are being conducted; blood will be drawn from young eagles for toxic analysis; video cameras will be used, and a limited amount of climatic and food availability information will be gathered. A proposal currently being considered by the Great Lakes Protection Fund would continue and expand the current study.

Restoration of Farm Woodlots at Gettysburg NMP

By Stephen E. Fairweather
and Cecile M. Cavanaugh

In the first three days of July 1863, the farm fields and woodlots of Gettysburg, Pennsylvania were the scene of one of the bloodiest battles in American history. In all, more than 50,000 men lost their lives in the fight that historians refer to as "the greatest battle of the Civil War."

Accounts of the battle of Gettysburg make it clear that the farm woodlots played an integral role in the fighting, providing cover, cool drinking water, and landmarks for orientation of the troops. Before the battle, the woodlots were an important feature of the landscape from a natural resources point of view, providing building materials, windbreaks, and cover for cattle.

Recognizing the importance of the farm woodlots, a study was begun at Gettysburg National Military Park in the summer of 1989 to develop a set of recommendations for "restoring" the woodlots, i.e. for managing them in such a way that they would appear much as they did prior to the famous battle.

Using a variety of information sources, including land survey records, battle accounts, photography, and our perceptions of the use of the woodlots, we determined that the typical farm woodlot was comprised mainly of oak and hickory species, and was uneven-aged. Each woodlot had to be uneven-aged in order to provide a continuous flow of products for the landowner. Such a woodlot would feature trees in all size classes, from seedlings to saplings to large mature trees. Typically, an uneven-aged woodlot has the "reverse-J" distribution of trees by diameter class (Figure 1), with a very large number of small trees and decreasing numbers of larger trees.

Extensive field work in the summer of 1989 and 1990 in each woodlot confirmed that, indeed, the woodlots were still uneven*aged, but that problems were developing. First, the species composition of the woodlots was slowly changing, such that the oak predominance was being replaced by a mixture of other species, including hickory and ash. Secondly, the numbers of seedlings and trees in the smallest diameter classes were fewer than was needed to sustain the uneven-aged nature of the stands (Figure 1). This probably was due to a combination of factors, most notably a lack of cutting (to create openings and promote regeneration) and a very high density of white-tailed deer. Much of Pennsylvania is experiencing difficulty in regenerating oak, and excessive deer browsing is considered to be a leading cause.

In our final report (Tech. Report NPS/MAR/NRTR 90-049), we recommended a controlled mixture of timber harvesting, tree planting, and forest protection in order to regain and maintain the nature of the 1863 woodlots. Light harvests, on the order of 15 percent of the trees in all size classes ever 10 years, will be needed to perpetuate the uneven-aged structure once it is restored. Removing a number of trees now will allow some sunlight to reach the forest floor and promote seedling growth. Those seedlings must be protected from deer browsing, either through individual shelters, large area fencing, or reduction of deer density. Supplemental planting (in seedling and/or sapling size classes) will be necessary in order to regain the oak species dominance. Spraying to minimize the impact of gypsy moth defoliation also will be important for maintenance of the woodlots.

Finally, regardless of management actions, the woodlots must be closely monitored to track changes in their size distribution and species composition. We recommended establishment of permanent plots for this purpose. Related studies by other Penn State researchers concerning vegetation and deer management also will help to insure the successful restoration and maintenance of the farm woodlots at Gettysburg.

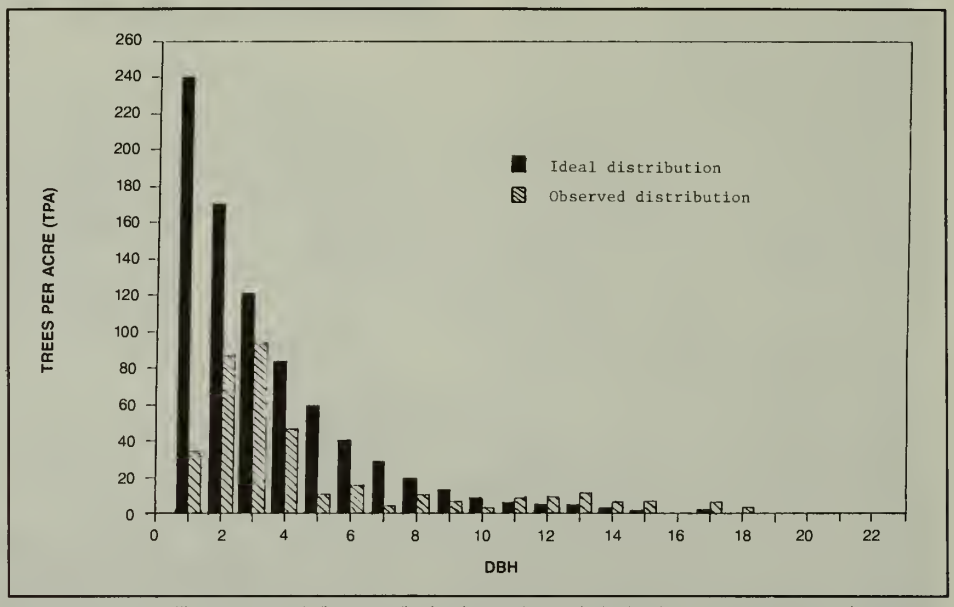


Figure 1. "Inverse-J" uneven-aged diameter distribution and actual distribution in one woodlot at Gettysburg.

Fairweather is a professor of forestry and Cavanaugh a graduate student at Pennsylvania State University.

mab notes

An exceptionally promising place joined the biosphere reserve family in March, when the MAB Bureau approved **Land Between the Lakes Area** (LBL) in Kentucky and Tennessee. Managed by the Tennessee Valley Authority (TVA), LBL is 95 percent surrounded by impoundments on the Tennessee and Cumberland rivers. This provides an opportunity, rare in the BR network, for studying land-reservoir relationships.

Four watersheds of about 500 ha each and numerous smaller forest stands will serve as the core area. The buffer zone will consist of the rest of the largely forested 68,800 ha national recreation area, on which carefully managed timber harvesting, hunting, and other recreation, agricultural use, and a strong program of environmental education and conservation demonstrations are held. Research projects sponsored by nearby universities are underway.

To coordinate the MAB regional program, a cooperative along the lines of the Southern Appalachian MAB Cooperative is planned. Proposed members include TVA, the U.S. Army Corps of Engineers, Tennessee and Kentucky state agencies, colleges and universities, four Area Development Districts, conservation organizations, and the Land Between the Lakes Association, which can develop public support and raise funds.

The U.S. biosphere reserve network will be further strengthened if **additions to two existing BRs** are approved. Four areas – Bodega Marine Lab (UC/Berkeley), Jasper Ridge Biological Preserve (Standord), Audubon Canyon Ranch in Marin County, and the Cordell Bank National Marine Sanctuary petitioned to join the Central California Coast BR. In the Southern Appalachians, Mt. Mitchell State Park and Grandfather Mountain petitioned to join that BR. This would bring state (North Carolina) and private sector representation to the Southern Appalachian BR for the first time. All the above add-ons have been recommended for nomination by the MAB National Committee but must wait nearly a year for the next meeting of the MAB Bureau to gain approval.

Use of and communication among BRs has been made easier by publication in January of the **Directory of Biosphere Reserves in the United States.** Compiled by Leslie Bord and David Figlio of the NPS Wildlife and Vegetation Division, the directory lists basic information for each BR, including names, addresses, and phone numbers of site managers, administrative staff, and professional staff. Copies may be had from the Executive Director, U.S. MAB Secretariat, Dept. of State OES/EGC/MAB, Washington, DC 20520-7818.

A briefing on the **Southern Appalachian MAB Cooperative** (SAMAB) was held at the Department of the Interior on April 25. Tommy Gilbert (filling in for Blue Ridge Parkway Supt. Gary Everhardt), Bjorn Dahl, supervisor of North Carolina national forests, and Hubert Hinote, executive director of SAMAB, presented their views on the cooperative's progress. The greatly increased communication among SAMAB members was seen as a primary benefit of the program. Ongoing projects focus on important regional resource issues such as dogwood anthracnose, the overharvesting of native plants, and the demonstration of ecologically and culturally appropriate alternatives for development.

A plan for Pittman Center, TN, has been completed with support from the Economic Development Administration, as a model for environmentally sound community development in the region. The SAMAB Foundation planned to hold its first fund drive in Spring 1991 to help support SAMAB projects.

Book Review

Little Islands Floating in Seas of Indifference?

NATURE RESERVES; ISLAND THEORY AND CONSERVATION PRACTICE 1990. by Craig L. Shafer. Smithsonian Institution Press. Washington and London, 189 pp. ISBN 0-87474-805-4.

Nature reserve design acts as the link that connects conservation with the sciences of biogeography, ecology, conservation biology, landscape ecology, evolution, genetics, demography, and more. Our use of this link has made it possible for us to examine such subjects as park shape and consequences of insularity. It has made it possible for us to study park capacity for protection, dispersal, emigration, population viability, and extinction. The production of technical literature contributing to various aspects of conservation, including facets of reserve design, has accelerated.

Park boundaries confine protection administratively but not necessarily ecologically; in addition, certain species, communities and processes are affected deleteriously or beneficially by this confinement. The complexity of these processes and the superimposed forces associated with human presence have been the object of controversy. A clear review and translation of available knowledge is badly needed, equally for managers and researchers interested in the conservation of natural areas.

Shafer's book presents these matters, focusing on what it is to conceptualize and design a nature reserve. He goes further to question whether we have any solid guidelines for reserve design. He reviews existing guidelines, and attempts to show a least-biased view of whether these are fine prescriptions or rules of thumb. He has designed his sections so that they are short, and easily read. The book's design simplifies reading for those who face interruptions or who wish to digest the information-loaded work, one small portion at a time. Throughout the book within sections, he immediately states the point and purpose of his writing and clearly summarizes his material so that it provides an excellent teaching, review and reference tool. The summaries also function as useful tests to judge whether one understands the essential messages delivered in the often complex arguments and controversies he describes.

The clarity and thoroughness of Shafer's style is refreshing and sorely needed. The benefit is not only for his primary intended audience, but for the community conducting research in contributing fields. Of special interest to managers and friends of U.S. National Parks: the author grasps and communicates all too well the impermanence of the "vignette." He uses writings of Leopold and Company effectively, providing interpretations that show considerably more depth than those previously made available.

The author focuses his attention on where lies the body of evidence that supports or conflicts with theories and hypotheses proposed in the literature. He recognizes the shortcomings of having a poorly documented institutional body of knowledge, and points out works having too little "real" documentation. Yet, his argument for stated shortcomings of the available theory also rests to a large extent on institutional experience. To this extent he permits himself reasonable editorial license. To do this conservatively, as he does, allows the body of managerial experience to serve as the testing platform for ideas. Ideally he could also use it as a stimulating mechanism for new research.

As the author of a major review he is in a good position to use his knowledge to produce the type of synthesis that would provide such a stimulation. But, he seems to have stopped short of this, perhaps intentionally. He holds tightly to his primary purpose of review and translation and, avoids jeopardizing the effectiveness of his translation effort. This may be disappointing to those reading this work for more than review or reference value. The author missed a unique opportunity to move forward, tying together the best of the professional literature and professional experience.

The subject treatment generally is exhaustive. He re-stresses that planning for nature reserves needs to consider cross-boundary processes, that buffers are necessary elements of protection, that reserves should be planned and designed with regional not just localized planning in mind. No less important is the need for human considerations, including population growth, economics, and social conditions, to be integral parts of the analysis. Yet, on having seen a section title for paleontology, I had expected to see a discussion of species associations and concepts of community as recent studies in paleoecology have treated them. The studies he represents do not include this subject area and the chapter lacks a discussion of changing insights regarding climax and stability of species associations.

Except for this minor point, the review is the most thorough and clearly presented one I have yet seen on the subject of nature reserves. While I may differ slightly in some interpretations, there are no subjects where I have clear departures in thought from the author. Shafer uses existing knowledge upon which to base his judgments, rather than trends in the popularity of concepts. Few of us can boast such a good handle on our material.

The section, "General Guidelines" in the end of his work (pp. 142-3) is an effective summary of the material. It rests on a basic foundation of knowledge, and fills a real need for review and translation. However, it is very much a collage of other similar lists of recommendations on reserve protection, design or management. It reflects his conservative approach, and shies away from synthesis. One of the most valuable messages the author stresses throughout, first caught my eye in his Preface. "The overall context of individual nature reserves, in relation to one another and to their modified landscapes and their people needs more careful concern." The guidelines provide observations that underscore this as a subject the designers of parks ought to focus upon.

Shafer's book will make an excellent reference and teaching tool, and will perhaps to be used more broadly than he anticipated. His work is a good introductory and refresher text on the uses, developments, applications and alternative hypotheses on nature reserve design. The 189 pages that report Shafer's review, comprise only the fine polished surface of what has been clearly a painstaking effort. The psychological analog he borrows for describing parks, as "Islands of pain in seas of indifference," sounds harsh, but is well chosen.

A footnote: For those who enjoy Shafer's book and are interested in more self-education on conservation of natural areas, I recommend John Perin's (1989), ***A Forest Journey; the Role of Wood in the Development of Civilization***. Published by W. W. Norton and Co., N.Y. This is a different type of review, a thorough historic analysis. It widened my perspective on the uniqueness and durability of 20th Century parks, beginning with Mesopotamia forests (4000 B.C.) and their subsequent depletions. History does recapitulate itself and, Schafer's book causes me to ask myself how the present differs from the past.

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Neotropical Migratory Bird Conservation Pact Signed

A Memorandum of Agreement for a Federal Neotropical Migratory Bird Conservation Committee was signed on May 14, 1991 by the USFWS, the USFS, the BLM, NPS, the Agency for International Development (AID), and EPA, and soon will be signed by the Department of the Navy.

The agreement establishes a Committee to identify priority conservation needs for neotropical migratory birds and to coordinate cooperative programs developed to address those needs. It also provides for establishment of affiliated working groups of technical experts from public and private sectors to determine needs for and to coordinate research, international population and habitat monitoring, information and education, and management programs being conducted by partnerships of federal, state, and local governments in the U.S., Canada, and Latin America, working together with private entities.

Neotropical migratory birds, those that nest in North America and winter in Latin America and the Caribbean, are in an overall state of population decline. Some species are so depleted they have been federally listed as threatened or endangered. These declines are the result of human activities – fragmentation of breeding grounds in the U.S. and Canada, and loss of wintering habitat in Latin America and the Caribbean.

A December 1990 workshop involving state and federal government agencies and a large number of conservation organizations proposed the conservation program and discussed activities and approaches similar to those already underway in an NPS pilot activity. This activity has been conducted for several years in the Southeast and Western NPS regions, aimed at establishing a Migratory Bird Watch that links park research, monitoring, and educational programs both nationally and internationally, according to the migratory birds shared by the parks.

The NPS has designated two Committee members and nine working group representatives, who will meet with two others in mid-July to draft an action plan for Service participation in the conservation program. NPS personnel include Mike Ruggiero, John Dennis, Ted Simons, Paul Buckley, Milford Fletcher, Richard Cunningham, Kyle Jones, John Peine, Rick Wilt, A. R. Weisbrod, Mike Britten, Norm Reigle, Jr., and Susan Savage.

John G. Dennis, Ecologist
Washington Office

Relict Vegetation Sites: Urgent Inventory Need for Desert Parks

Editor's Note: This article is in partial fulfillment of a Cooperative Agreement between the Western Regional Office of the Nature Conservancy and the NPS Rocky Mountain Regional Office.

By Nicholas Van Pelt and Joel S. Tuhy

On the Colorado Plateau of Arizona, Utah and Colorado, an appreciable fraction of the land surface and its vegetation is in a pristine state. This results from the innumerable buttes and mesas so characteristic of this exceptionally scenic ecoregion. Most such terrain "islands", along with narrow canyons and steep, rocky slopes, are inaccessible to livestock, vehicles, and even humans. The plant communities of these "relict areas" have entirely escaped the influence of the major land uses of the Plateau: fossil-fuels extraction, hard-rock mining, firewood and post cutting, cattle grazing, and dispersed recreation.

The 13 national parks, monuments and recreation areas of the northern Colorado Plateau have their share of relict sites, but no verification of their existence and description of their features was undertaken until recently. Since 1986, The Nature Conservancy's Great Basin Field Office (GBFO) and the Rocky Mountain Region (RMR) have surveyed potential relict sites within NPS units in Utah and western Colorado. The first of two projects, requiring much helicopter time, yielded thorough descriptions of 22 sites within Glen Canyon NRA. The second phase involved all other units of the northern Plateau, from Zion in southwestern Utah to Curecanti in west-central Colorado. The more southerly units, in Arizona and New Mexico, have not yet been surveyed (University of Arizona scientists identified several sites within Grand Canyon in the late 1970s).

A Precious Resource

Almost all desert parks had sustained nonconforming uses before establishment. Several units, such as Capitol Reef, still support authorized grazing or cannot fully exclude trespass livestock. Accordingly, relict sites are a precious and limited resource, intrinsically valuable and useful for gauging departures from "naturalness" caused by grazing in particular.Today's inquisitive recreationists have sought out and affected a few sites, such as Canyonlands' Virginia Park.

Because relict areas are indeed remnants of pristine landscapes, and could be lost through park development, trespass, or inappropriate visitation, the Conservancy and the RMR felt that it was imperative to learn about and safeguard as many as possible. Some sites will contribute to state-based or plateau-wide Research Natural Area (RNA) networks maintained in concert with other federal agencies. Given Service-wide initiatives in climatic change monitoring and assessment, the relict sites afford secure places where monitoring equipment, sampling protocols, and photographic stations could be placed – with assurance that these will remain undisturbed. Most importantly, the sources of vegetational and faunal changes over the coming decades will not be confounded with influences present elsewhere in the same parks.

74 Catalogued Sites

The 74 sites visited and catalogued range in size from five to several thousand hectares. The largest and therefore most diverse of them occur in Canyonlands, Glen Canyon and Zion.The vegetation present ranges from blackbrush (*Coleogyne*) semidesert shrubland through a great variety of pinyon-juniper (*Pinus edulis-Juniperus osteosperma*) woodland subtypes to montane or subalpine ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) and Engelmann spruce (*Picea engelmanii*) habitat types. Four bristlecone pine (*Pinus longaeva*) forests, all with endemic plant concentrations, were surveyed. One, comprising the only montane forest area in Capitol Reef, will receive its first dendrochronological evaluation this year by the Laboratory of Tree-Ring Research.

Following completion of the Glen Canyon phase, the Conservancy compiled a master vegetation classification for the Colorado Plateau. The units in the forest, woodland, shrubland, grassland and "other herbland" series included were used as a checklist in the surveys, which turned up additional types. However, the sites do not constitute full samples of the vegetal types present in any of the parks, with the exception of Glen Canyon. There, it is possible for resource managers to revisit and intensively characterize pristine examples of nearly all rangeland communities affected by the NRA's grazing program.

Photo Stations Installed

A key adjunct of the largely qualitative surveys was the installation of permanent, unobtrusive photographic stations. Surveyors acquired 50- to 400-mm color slide panoramas with a professional camera and tripod set up at measured distances above the station nadirs. The resulting pictures afford a vivid and repeatable record of vegetation and surfacial features. Trees and shrubs are frequently identifiable, making some of the 740 images useful for long-term, individual-plant-based studies. The photographs are archived in three final-report volumes (one each for southwestern/south-central Utah, western Colorado, and Canyonlands). Directions for rephotographing the scenes (perhaps in 10 years) are included. The project has therefore substantially augmented the collective portfolio of desert landscape photographs that can be reliably matched in the future. They can be used to complement more specialized, data-based resource monitoring and research efforts. In the 1990s, ecologists and photogrammetrists may devise novel ways of extracting insights from conventional photographs, especially those that are carefully matched.

Surveys Inexpensive

These surveys of parklands typifying "base conditions" are timely and comparatively inexpensive. They also respond to the Park Service's mission of retaining a sample of pristine natural environments for inspiration, upper-level education, and both park-based and academic research. Some relict sites can become RNAs, but in any case all can be better understood and more knowledgeably managed with the information, data, and photographs the Conservancy and the Park Service have acquired. The site writeups will appear in three volumes (companion to the photo archives) this winter, and both project phases will be described in a forthcoming ***Natural Areas Journal*** article.

The project originators envisioned a third phase involving northern Arizona parks and monuments, plus Chaco Canyon in northwestern New Mexico. Grand Canyon and Petrified Forest are the most likely to harbor significant relict vegetation occurrences. Still other parks, in the Mojave and Sonoran deserts, could likewise benefit from surveys (augmented with repeatable photography) that are performed before anticipated global-warming effects on drylands begin to register. The relict sites within NPS lands in the southwest could well be crucial in meeting the challenge of understanding and controlling these effects, plus those of steadily increasing visitation.

Van Pelt is Utah Public Lands Coordinator with The Nature Conservancy's Great Basin Field Office in Salt Lake City, UT; Tuhy is Coordinator of the Utah DNR's Natural Heritage Program.



Junction Butte, *Canyonlands National Park, Utah. A relict area showing differences in plant composition in comparison to the nearby "mainland." Photo by Charles Schelz.*

Seeing the Forest for the Trees: An Analysis Of Cumulative Impact in Environmental Documents

By Ron West

The other day I glanced through a random back issue of ***Park Science***. Several articles and resource issues caught my attention: Urban Development Near Parks; Man and the Biosphere; The Boundary Approach to the Analysis of Nature Reserves; Biodiversity Task Force; and Ecosystem Management in the Parks.

All of these current topics are ultimately concerned with the analysis of cumulative impact. Each, in its way, is an attempt to grapple with a bigger picture; each considers a holistic approach to park resources and the multitude of influences that affect them.

Many of these relatively new issues, however, are theoretical or conceptual in nature – few are solid enough to be dealt with in our day-to-day, working world. My day-to-day working world often deals with environmental compliance, primarily compliance with the National Environmental Policy Act (NEPA). An analysis of cumulative resource impacts in the environmental assessment (EA) process would be a relatively down-to-earth way to tackle some of these bigger-picture concerns. What's more, it's a legal requirement to do so.

Cumulative Impact and NEPA

Attempts at analyzing cumulative impact are quite new, and no one has written the definitive book on how to go about it. The NPS, USFS, BLM, and numerous states are currently trying to deal with cumulative impact in the planning process. Major planning efforts in Big Cypress, Denali, Wrangell-St.Elias, and Yellowstone all have addressed recently the cumulative impacts in controversial arenas.

The new interest in cumulative impact analysis has come about largely through intervention of the courts. Numerous agencies have been handed a court order for a cumulative impact analysis and/or an Environmental Impact Statement incorporating such an analysis. In virtually every court case I've read about, if the plaintiffs ask for cumulative impact analysis then the court has ordered it. The reason for this is that the need for such an analysis is cited numerous times in the NEPA regulations. Although these regulations date from 1979, this language is only now being discovered.

The Council on Environmental Quality's (CEQ's) definition of cumulative impact, as stated in the NEPA regulations, is at the heart of the matter. The definition states that cumulative impact is "the impact on the environment which results from the incremental impact of the action *when added to* other *past*, *present*, and reasonably foreseeable *future* actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7; emphasis added).

To say the least, this is a rather comprehensive definition.Nearly anything which has or will affect the resources of concern needs to be examined and considered. A simple way of defining the analysis of cumulative impact, sometimes mentioned in the literature, is that the analysis should cover all impacts over both *space* and *time*.

Cumulative Impacts and Olympic EAs

In 1988, four development concept plans were completed for four areas on the west side of Olympic NP. An attempt was made in the environmental assessments for these documents to address cumulative impacts on particular resources. The most important resources of concern were elk, anadromous fish, and old growth forest stands. Cumulative impact was addressed in two, somewhat related areas: 1) in the presentation of existing resource conditions and impacts *outside* of the park boundary; and 2) in the presentation of *past* resource impacts.

1) Resource Conditions and Impacts Ouside the Park Boundary

From an ecosystem perspective, the park boundary was considered to be almost meaningless. Elk and salmon do not recognize the administrative boundary in their movements. Old growth stands don't migrate, but existing old growth harvesting policies outside the park are isolating remaining old growth communities in the park. Politically, of course, the park boundary is quite real. How far one may go in the EA in presenting external concerns depends on the particular park, and its local politics.

In dealing with trans-boundary, cumulative concerns we presented information in three ways.

A) *Relevant Region-Wide Resource Information.* Stating the simple fact that salmon move up the river into the park leads the reader to an understanding that "park" fish can be (and are) impacted by downstream non-park actions. Elk also move in and out of the park. We simply tried to show that the park is not an island – that there is a common, regional resource base. Apparent enough to us, perhaps, but often not understood by readers. It needs to be spelled out.

B) *Watershed Information.* In an attempt to present more realistic resource "boundaries," we presented the percentage of a watershed that was inside and outside the park. This was simply done by outlining the four major river watersheds on a regional map and computing the areas both inside and outside the park. This information was presented, for example, by stating that: "In the Quinault River watershed, 52% of the land area is within the park; 48% in other ownership." The idea being that the NPS, even under the most preservation-oriented management of resources, can only influence 52 percent of the land base on which the resources depend.

Presenting watershed information makes sense for anadromous fish; for elk and old growth even a watershed "boundary" is artificial, however, it comes much closer to portraying an ecological unit than a straight park boundary created along section lines.

C) *Graphics.* We tried to visually portray a cumulative impact approach. A map of existing conditions included extensive areas outside of the park boundary. Any "external" human activity which contributes to impacts on a common resource base, even if the details of the impact are sketchy, can be presented graphically, e.g., areas of oil and gas development, sub-divisions, upstream dams – all can be germane to the issues being examined in the EA. The areas don't have to be precisely located on the map, either. A bubble diagram approach, showing the general area and the type of impact could be adequate. In the Olympic case, the biological isolation of detached park units could be visually portrayed by surrounding the unit in a sea of precisely mapped clear cuts.

2) Past Resource Impacts

Documented, past resource impacts, and the subsequent current resource conditions resulting from them, also were presented. The critical thing that this information does is to establish a historic or "pristine" baseline from which to measure additional impacts stemming from the NPS proposal. For example, in one watershed, harvest figures for sockeye salmon declined from 25,000 to 30 (or a 99.8% reduction) from 1949 to the present. Although harvest figures do not necessarily represent population figures, this sad fact goes a long way in saying that we better be darn careful that NPS impacts do not add any more reductions to the runs.

To me, this baseline is perhaps the most important factor that cumulative impact analysis can contribute. Hypothetically, we might currently have a sockeye run of, let's say, 100 fish. With this information, standing alone, it could be said that an estimated "small" reduction from an NPS proposal would not be considered a significant impact. But when looked at in a historical perspective, knowing the run used to have, say, 10,000 fish, it's quickly apparent that there has already been a significant past impact, and any additional impact from our proposal would compound an existing significant impact.

The presentation of past impacts should avoid fixing "blame," but the causes for the impact, such as "reduction of spawning habitat due to siltation from roading and logging activity," should be brought out. In some cases, years of continuous impact were presented: "significant change in natural forest vegetation has resulted from extensive logging over the past 90 years." The extinction of species in the ecosystem, the ultimate past impact, was stated as well (for wolf).

It might be an uphill endeavor to convince supervisors, superintendents, or regional staff of the necessity of a cumulative impact approach to EAs. The resource protection arguments are the strongest to me, but the legal/CEQ argument mentioned here might convince others. I believe that the result, however, is worth the effort – the more NPS people and public reviewers that are thinking in a bigger picture, the clearer the bigger picture will become.

Ron West is a Natural Resource Specialist at the Denver Service Center.

Coastal Barriers Focus of BioScience Articles In May 1991 Issue

Five articles focusing on coastal barrier ecosystems and on the Biosphere Reserve concept make up the bulk of the May 1991 issue of ***BioScience***. For a well-rounded look at these resources, the management challenges they pose, some proposed tools for their management, and the need for public education, the May issue is recommended reading. The articles and their authors are: "Establishing Biosphere Reserves for Coastal Barrier Ecosystems," by G. Carleton Ray and William P. Gregg, Jr.; "Long-term Research at the Virginia Coast Reserve," by B.P. Hayden, R.D. Dueser, J.T. Callahan, and H.H. Shugart; "The Biosphere-Reserve Concept: Needs for a Network Design," by M.I. Dyer and M.M. Holland; "Public Education for Protecting Coastal Barriers,"by Gary W. Mullins and Hans Neuhauser, and "Management of Coastal Barrier Biosphere Reserves," by John R. Clark.

Ecological Effects of Stocked Trout On North Cascades Naturally Fishless Lakes

By William J. Liss and Gary L. Larson

One generalization that has emerged from research into the ecological role of fish in aquatic communities is that fish can play an important role. When stocked in historically fishless bodies of water, fish have the potential to eliminate or severely reduce in abundance indigenous species of invertebrate and vertebrate prey organisms and thus dramatically change aquatic community composition and development. In general, management concerns center on balancing recreational opportunities provided by stocked fish and conserving the integrity of aquatic communities that have developed for thousands of years in the absence of fish.

The lakes of North Cascades National Park service Complex in northern Washington were formed by glacial activity thousands of years ago and, until relatively recently, were devoid of fish. Some lakes were stocked with trout in the early 20th Century, long before establishment of the park in 1968. At present, of the 160 or so significant high mountain lakes, about 61 contain fish, either through natural reproduction or by periodic stocking. The major species are cutthroat and rainbow trout.

Park staff now face the difficult task of deciding the future of fish stocking of lakes within park boundaries. This research was undertaken to clarify the ecological role of stocked trout and their potential effects on the biological communities of naturally fishless high mountain lakes. We have completed two of three scheduled field seasons and are analyzing data collected during the second season. This paper then, is an interim report and deals primarily with our accomplishments prior to beginning field work and during our first field season.

Before the start of each field season we meet with a peer review panel of limnologists, all with research experience on lake communities, to review our work of the past year and our research proposal for the succeeding field season. This has provided constructive reviews and had a significant impact on research directions. Park staff, especially Jon Jarvis, Gary Mason, and Bob Wasem, have provided logistic support and personnel assistance. Beth Deimling, Bob Hoffman, Gregg Lomnicky, and Bob Truitt, all research assistants at Oregon State University, have major responsibility for conduct of field work, processing samples, and data analysis. Collaboration of our colleague, Dave McIntire, also is appreciated.

A Diverse, Dynamic System

The park is a diverse, dynamic system--an area of steep, rugged mountains, some reaching elevations of over 2500 meters, with many permanent glaciers. The mountains and valleys were shaped by glacial activity over the last 10,000 years. Prevailing weather patterns are from the Pacific Ocean, about 50 miles west of the park. Precipitation is highest west of the Cascade crest, which runs through the park. Most of the glaciers are found on the west side; areas east of the crest are much drier.

The park's high mountain lakes are generally rather small, most having a surface of less than 10 hectares, although some are quite large. They occur at elevations ranging from less than 500 m to over 2000 m. Lower elevation, west slope watersheds have well-developed soils and are heavily forested. Higher elevation watersheds may have little soil development and be very sparsely vegetated; many of the highest watersheds are largely rock and ice. The park's oldest lakes probably are thousands of years old, but new lakes are forming even today as the glaciers recede.

Our research began with a literature review of the ecological impacts of fish on aquatic communities (Goetze et al 1989), and development of a watershed and lake classification system for the park (Lomnicky et al 1989). The literature suggests that vertebrate predation can alter aquatic community structure and organization. **Structure** of aquatic communities can be defined as the kinds of species composing a community, their abundances, distributions, and average sizes. This structure is simply a description of the "form" of a community. **Organization** involves interactions or interrelations, at least partially inferred, among species or groups of species that give a community its cohesiveness and ultimately underlie its "form."

Fish have been shown to alter the size-structure, species composition, and species abundances of crustacean zooplankton. Fish may selectively prey on the largest or most visible species, eliminating these species or severely reducing their abundance and causing the zooplankton community to be dominated by smaller forms (e.g. Zaret 1980). These changes are thought by some researchers to alter grazing rates on phytoplankton and cause changes in the species composition, size-structure, and abundance of these minute algae (Carpenter et al 1985). Fish may change the biomass and relative proportions of taxa composing benthic macroinvertebrate communities (Gilinsky 1984; Walters and Vincent 1973; Andersson et al 1978; Tuunianen 1970). Elimination of benthic species has been reported (Macan 1966a,b; Reimers 1979). Fish also may alter the behavior and abundance of salamanders (Efford and Mathias 1969; Taylor 1983; Semlitsch 1987).

Many Factors Involved

While there is considerable evidence suggesting that stocked fish can alter communities in naturally fishless lakes, the results often are not clearcut. Community structure and organization are by no means determined solely by presence or absence of vertebrate predators. Species that successfully colonize a lake and make up a community must, at some time, have originated in other lakes, streams, and bodies of water. The system of aquatic communities that provides colonists to a lake is the species pool. The composition of species in a lake depends heavily on this pool of available colonists.

In addition, the physical and chemical characteristics of the lake habitat influence the kinds of species present and the nature of species interrelationships. Lakes with different kinds of habitats may have somewhat different communities, even within the same species pool, and these communities may respond differently to fish stocking.

Prey refuges, which can mediate the effects of predation, are a component of habitat (Crowder and Cooper 1982; Timms and Moss 1984). Fluctuations in chemical and physical conditions may reduce, enhance, or override effects of fish predation. Impacts on the community also may depend upon the species, density, and age and size structure of vertebrate predators (Stein et al 1988).



***Doubtful Lake** is a subalpine lake formed in a glacial cirque in North Cascades NPS Complex. (Photo by Beth Deimling)*

Most high mountain lakes of the North Cascades are oligotrophic, that is low in nutrients and poorly productive. Yet there is considerable diversity in characteristics of lakes and their watersheds, which may give rise to diversity of aquatic community types. Watershed and lake classification provide a useful tool for identifying, ordering, and understanding diversity of aquatic habitats and communities. Lakes, like all aquatic systems, reflect characteristics of their watersheds.

Lakes within the park are classified or grouped according to climatic, geologic, topographic, and vegetative aspects of their watersheds, and by watershed area, lake elevation, lake morphometry (surface area and relative depth), and type of inlet and outlet. All these characteristics may influence lake habitat including chemistry, hydrology, length of ice-free period, seasonal temperature patterns, and type of bottom substrate.

The classification, then, allowed us to begin to define different aquatic community habitats within the park, and associate these habitats with watershed characteristics. In addition, the classification system provided a basis for selecting comparable lakes for study and will serve as a tool in developing a lake monitoring program.

Research Season Limited

Field research began in the summer of 1989. Field seasons are relatively short, extending from June into September for the lowest elevation lakes. Many high lakes may not become ice-free and accessible until mid to late July. Lakes often are located in rugged, remote terrain and so present severe logistical difficulties for the researcher transporting sampling equipment. Access to nearly all lakes is either by backpacking or helicopter.

The goal of research is to evaluate the impacts of

stocked trout on the structure and organization of aquatic communities in naturally fishless lakes. The components of the aquatic community on which we focused included benthic macroinvertebrates, crustacean zooplankton, rotifers, phytoplankton, and amphibians--particularly salamanders. Fish were sampled to determine size structure, food habits, and relative abundance. Lake chemistry and temperature profiles were taken and components of the benthic substrate were identified and mapped.

Since very little was known of the structure of aquatic communities within the park, our first field season task was to conduct an extensive survey of lakes. The 1989 field season was devoted to assessing the general limnological characteristics of 52 lakes, which represented a wide range of lake classes. Most were sampled only once that season. The survey afforded some important understanding of the species composition of aquatic communities and species distributions among communities within the park, and led to some hypotheses concerning fish impacts, which directed further studies and provided context for more intensive field studies conducted in ensuing years. Analysis of the 1989 survey data led to the tentative view that predation impacts on aquatic communities in the park may be dependent on the density and size structure of vertebrate predator populations and may vary with lake class.

Vegetation zone (alpine, subalpine, and forested) and aspect (east/west) are components of the classification system that emerged as important indicators of local climate, soil conditions, and limnological characteristics of lakes (Liss et al 1990). Physical and chemical properties of lakes and benthic habitat characteristics varied among vegetation zones. In general, taxa of zooplankton, benthic invertebrates, and phytoplankton were more diverse in forested lakes than in subalpine and, particularly, alpine systems. Many taxa, some of them relatively rare, were found exclusively in forested systems. This suggests that analysis of fish impacts should be partitioned by vegetation zone.

Fish Effect on Salamanders

Important vertebrate predators within aquatic systems in the park are fish and salamanders. Both prey upon benthic macroinvertebrates and zooplankton. Fish seem to affect the abundance and behavior of salamanders. When fish were not present in a lake, salamander abundance was relatively high. Salamanders were observed to move freely within the lake during daylight hours, suspend in the water column, and bask openly on submerged rocks and logs. When fish were present, abundance of salamanders appeared to be reduced and they were far more secretive, lying hidden in crevices of submerged boulders during the day, perhaps emerging to feed at night. Salamander larvae were found in fish stomachs. Preliminary observations suggest that post-hatch mortality of larval salamanders is very high in lakes with fish. We will be performing experiments during the 1991 field season to determine the extent to which this mortality may be attributable to fish predation.

Both reproducing and non-reproducing fish stocks are present in the park. Reproducing populations are composed of individuals of different ages and sizes. Park lakes with highest fish densities tend to be composed of reproducing fish populations. Our initial observations suggest that these may be the lakes in which fish impacts on salamanders and invertebrates may be most evident. Lakes in which fish do not reproduce are stocked periodically with fry. Fish in these lakes tend to be of more uniform size and age. Since fish may change their feeding habits as they age (Rabe 1967; Hansen 1971), a cohort of stocked fish may have different impacts on the community when it is composed of numerous small fish than when it is made up of few, large fish. This raises the possibility of cyclic changes in aquatic invertebrate community structure as a cohort of stocked fish matures.

... predation impacts ... may be dependent on the density and size structure of vertebrate predator populations and may vary with lake class.

Unraveling Complexities

Research during the 1991 field season, as in the 1990 season, will be directed toward unraveling the complexities of interactions among components of the aquatic communities. Two types of approaches will be employed. One involves comparison of communities in lakes with different levels of vertebrate predation within each vegetation zone. In the subalpine, this will entail comparison among lakes in which no vertebrate predators are present, lakes in which only salamanders occur, and lakes with low to high densities of fish. In forested lakes, the same design will be employed, although we have not found any lakes in this vegetation zone that do not have some type of vertebrate predator. For each community we will focus on assessment of species composition, average body size of major species, relative species densities, and habitat utilization. Lakes will be sampled two to four times per season, depending on elevation. Alpine lakes will not be studied extensively because few are stocked with fish.

The second approach pertains primarily to lakes with non-reproducing fish. Community structure in two subalpine and three forested lakes, each with only a few, large fish remaining within the cohort, was determined. Predation intensity, particularly on zooplankton, may be rather low in these systems. The large fish then were removed by intensive gill-netting (only relatively small lakes that afford high probability of removing nearly all fish were chosen). The lakes were restocked with fry toward the end of the 1990 season. These smaller fish may be more intensive planktivores than larger fish and so have a greater impact on zooplankton and the pelagic community.

Community structure will be determined again during the 1991 fields season and compared to structure from 1990. Sampling these systems we hope can continue during a monitoring phase of the project to evaluate whether some form of cyclic change in communities associated with periodic stocking can occur.

Liss and Larson are limnologists, Liss with the Oregon State University (OSU) Dept. of Fisheries and Wildlife, and Larson with the NPS/CPSU at OSU, Corvallis, OR.



***Pelton Basin** in North Cascades National Park Service Complex. (Photo by Beth Deimling)*

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The Natural Resource Publication Program

(Continued from inside cover)

Based on these recommendations, and after extensive field review, the AD/NR approved *The Final Plan For Designing and Operating the National Park Service Natural Resources Publication Program* in March 1989. The approved plan established the foundation of the publication program. The "nuts and bolts" of the program would evolve over the next two years of implementing recommendations for the plan and writing, reviewing, and revising the procedural handbook.

How has the program evolved and what is it today?

The program, under the administration of the AD/NR, provides a coordinated direction, purpose, and focus for disseminating natural resource information through (1) NPS natural resource publications, (2) other NPS publications, and (3) publications outside the NPS.

Five NPS report series and the quarterly ***Park Science*** bulletins are available at the national level to disseminate natural resources information. The five report series are the Scientific Monographs, Transactions and Proceedings, Technical Reports, annual Science Reports, and Natural Resources Reports. The AD/NR funds and approves manuscripts disseminated through the national report series. The Publications Coordinator coordinates the selection and approval processes and the editorial and publishing services. Three of the six series are available at the regional level to disseminate natural resource information. The three report series are the Technical Reports, annual Science Reports, and Natural Resources Reports. These series are optional; some regions may use all three, others only one. Approval authority for a regional series is at a Regional Director's discretion. No other natural resource series may be used or developed, and parks must disseminate information through an established natural resource series at a regional office or a cooperative park studies unit.

Some of the common program elements which link the national and regional series are: (1) National and regional series are managed in accordance with publication management and printing authorities, statutes, and regulations. (2) Both levels of series are managed under the same objectives, management strategies, and general publication policy. (3) Each series is clearly defined as to the purpose, audience, content, type of review, format, and review procedures, with each having a consistent series numbering system and an NPS reference number. (4) Identical information is presented on the covers, the inside front covers, the title pages, and the inside back covers for each series report, national and regional.

What has the program accomplished so far?

The planning process that allows for competing needs, long*term scheduling (for editing, reviewing, producing, and printing), and long-term budgeting for national series has been successfully implemented, and manuscripts published, since last year. Funding also has been provided for page charges and reprints to support scientists publishing in outside journals. The Advisory Board, formerly the task force, has met every year since the initiative began; it recently addressed the issues of the new NPS Science Editorial Review Committee and priorities for program resources. The Technical Information Center at the Denver Service Center maintains a bibliographic database for natural resource publications; and a procedural handbook, following extensive reviews, has finally been completed.

Almost everything you wanted to know, but until now were afraid to ask, about disseminating natural resource information through publication is contained in the ***Natural Resources Publication Management Handbook***, including guidelines for NPS publications outside the NPS. Completing this handbook is a significant accomplishment and would not have been possible without the continued support and contributions of the Chief Scientists, the Advisory Board, and dozens of reviewers.

The handbook is available from the Chief Scientists or the Publication Coordinator, Natural Resources Publication Office, P.O. Box 25287, Denver, CO 80225-0287; (FTS) 327-2156 or (303) 969-2156.

O'Leary is NPS Publications Coordinator.

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PARK SCIENCE
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El Malpais Wilderness Suitability Study

By Ken Mabery and Dave Kenney

On Dec. 31, 1987, Congress established El Malpais National Monument (NM) on the southeastern edge of the Colorado Plateau. "The bad country" (EL-MAL-pie-EES) was aptly named by Spanish explorers for the trackless, broken lava flows covering about 230 square miles in northwestern New Mexico (75 miles west of of Albuquerque). The 114,848-acre monument contains one of the more recent lava flows in continental United States and has kipukas, cinder cones and other craters, spattercones, pressure ridges, important lava edge ecotones, and more than 50 miles of lava tube systems, some with unusual ice formations and flora and fauna species.

Other features include archeological sites dating from the Archaic (5000 B.C.) through Anasazi (A.D. 1350) periods and continuing to modern Navajo and Pueblo cultures and pristine vegetation associations such as aspen and Douglas-fir stands of pinion and juniper.

The El Malpais legislation also created a 262,600-acre BLM national conservation area (NCA), which almost surrounds the monument and within which are two designated wilderness areas. These areas (totaling 102,400 acres) border the monument on the south and east. The legislation required the development of simultaneous management plans for the NPS monument and the BLM conservation area.

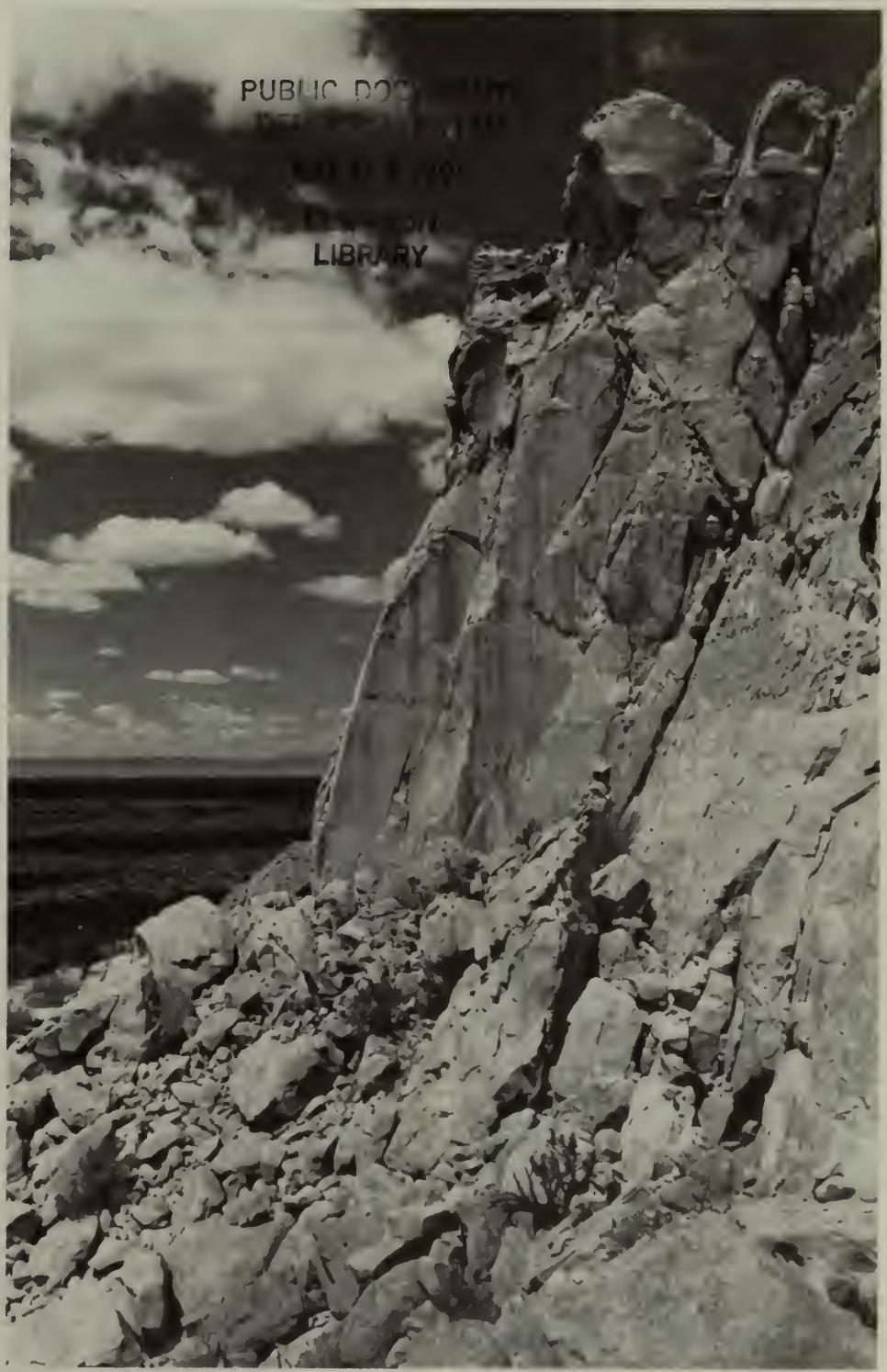
A further legislative requirement was a wilderness suitability study – an inventory of lands suitable for wilderness designation. This article deals with the NPS approach to and conclusion of that study and the problems encountered.

Background

Legislative provisions that influenced the mandated wilderness study are: (1) the general management plan (GMP) "shall review and recommend the suitability or nonsuitability for preservation as wilderness of all roadless lands within the boundaries" (hearing language defined "roads"); (2) a map of potential development zones that did not have to be inventoried; (3) development of two visitor centers and traditional NPS facilities to provide for the enjoyment of ...; (4) phaseout of grazing by 1998 (eliminating many existing roads and other incompatible intrusions); and (5) continuance of traditional American Indian practices and access consistent with the Wilderness Act.

Because of simultaneous deadlines, only one week was allowed for wilderness fieldwork. Topo maps and air photos were essential for locations of roads and other major intrusions. Most intrusions were adjacent to the lava flows and associated with past lumbering and grazing activities. Field inventory and evaluation concentrated on applying the Wilderness Act criteria,

(Continued on page 3)


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Cliff at Sandstone Bluff, with McCarty Crater flows in the background. Photo by Dennis Daily.

PARK SCIENCE

NATIONAL PARK SERVICE

SPRING 1991

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

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Authors, Please Note!

It has come to our attention recently that several manuscripts mailed to ***Park Science*** over the past year have not reached our editorial office. In October 1989, that office moved from Oregon State University's Forestry Sciences Lab to the address that has since then appeared in our masthead:

Jean Matthews
4150-A S.W. Fairhaven Drive
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The University no longer forwards mail directed to the old address, so if you have been wondering what happened to your deathless prose, chances are it never reached us. If it can be updated and still deserves dissemination, try us again.

editorial

Editor's Note: *In the serendipitous way that things often happen, editorially, for* **Park Science**, *a veritable spate of cave-related articles appeared in our mailbox. That this occurred at the same time that WASO was pre-empting the Southwestern Region's Chief Scientist for help in establishing a national node for cave research and management, provided this issue of* **Park Science** *with a focus that is herewith introduced by SWR Chief Scientist Milford Fletcher in the following guest editorial.*

* * *

During the week of Feb. 11, 1991, I met with NPS Deputy Assoc. Director Denny Fenn to outline the tasks related to the recently passed Act directing the NPS to accomplish two tasks:

(1) Establishment of a Cave Research Program "to provide for the orderly and scholarly collection, analysis, and dissemination of research material related to caves in lands managed by the NPS including, but not limited to, Carlsbad Caverns NP and the Capitan Reef area" (a geological formation), and

(2) Transmission to Congress of a report on the feasibility of establishing a Cave Research Institute. The report shall consist of a study covering "the need for such a facility, its costs, its purposes, what the facility should include, and where it should be located. Analysis of potential sites for the Institute should include, but not be limited to, Carlsbad Caverns NP."

The Division of Natural Resources and Science in the NPS Southwest Region has agreed to be the main contact for the first task. The second task will be completed by one of the various planning organizations, pending funding for the study.

We are currently formulating a work plan for approval by the Directorate in Washington which will outline, in general terms, the main thrust and direction of such a nationwide cave research program and what it would look like.

The exciting thing about this legislation is that finally we are getting a chance to look at cave research needs on a nationwide basis. An initial list of these needs will be obtained from the recently submitted Tables and Charts, updating the resource management plan from each park area. This legislation has the potential to gather an information base on cave-related research, open lines of communication among a diverse group of cave researchers, and formalize a nationwide program of cave research and management based on the most recent knowledge of karst processes.

Since caves represent a priceless source of information on paleontology and anthropology, the participation of a wide variety of research directions and disciplines is virtually assured.

(See Kerbo's "Caves and the NPS" on page 5.)

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El Malpais Study Poses Problems

(Continued from page 1)

the "road" definition, and evaluation of other intrusions. All identifiable roads and ways were field checked and evaluated for need and intrusiveness. The latter proved very difficult; many determinations were changed as planning progressed and additional consultations occurred with tribal groups. Data were circulated between NPS and BLM planning teams for additional review and comment. Finally, all pertinent data were transferred onto a permanent base map.

Crystal Ball Needed

Because the El Malpais wilderness study was part of the GMP process, an integrated team was assembled to determine the most appropriate potential land uses. This was critical to the wilderness study because NPS management of the monument had begun only a few months prior to starting the GMP and there was very limited visitor use and resource data base (first field staff were hired in July 1988; GMP fieldwork started that August). To balance wilderness preservation and other legislative requirements, it was necessary first to determine development and access needs for resource protection, and visitor, administrative, American Indian, and private uses. Because of limited data, this required some crystal ball type work.

Although El Malpais' legislative map designated some potential development zones that did not have to be evaluated for wilderness suitability, these were inventoried anyway; those suitable (after planning needs were met) were included as wilderness-suitable lands.

The authors found some unique circumstances during this study. The lava flows show almost no evidence of modern humankind. For the most part, the rugged lava flows preclude developments, and no further exploration was required on a sizeable portion of the monument. For approximately 58 of the 131 linear miles of monument boundary, many lava flow edges roughly coincide with monument boundaries, making ecosystem and physiographic boundary identification and protection relatively easy. A strong desire to simplify management with the adjacent BLM West Malpais Wilderness Area made analysis along approximately 33 miles of common boundary less complex. This left about 40 linear miles that presented the difficulties discussed here.

Lack of Guidance

The NPS's ***Management Policies*** devotes a chapter to wilderness; however, the chapter primarily addresses operational management rather than the study process. Another potential guidance source, NPS-2, ***Planning Process Guidelines,*** lacks any reference to wilderness studies. A review of other, older NPS wilderness studies proved to be the best overall guidance, as discussed here later.

The Senate report mandated the use of the BLM's definition of road – "a vehicle route which has been improved and maintained by mechanical means to ensure relatively regular and continuous use." A way, on the other hand, was "a vehicle route which has not been improved and maintained by mechanical means." For this wilderness study, "maintained" and "relatively regular and continuous use" needed further definition. Fortunately, BLM was wrestling with the same criteria on its nearby Chain of Craters Wilderness Study Area; we shared each other's ideas and thoughts. Still, what evidence of maintenance will you find on a road in an open grassy flat? In a remote, isolated, rugged area, what is "relatively regular" use? Once a month? Once a year?



Inside Bandera Crater *within El Malpais National Monument. Photo by Dennis Daily for the Cibola County Beacon.*

Obtaining the Needed Data

Numerous vehicular routes were not on topo maps or range inventories, and some were not even apparent on aerial photographs. Up to a year after the fieldwork, at least six vehicular routes were discovered, which made keeping up with acreage calculations and determining wilderness boundaries very difficult.

Do We Evaluate Private Lands for Wilderness Suitability?

Another problem was how to deal with private lands within the monument. Should they be evaluated before being acquired? No guidance is given for evaluating these private lands. In our final analysis, the private lands were evaluated and when those private lands that meet wilderness criteria are acquired, they will be considered as wilderness-suitable lands. (For purposes of the study, these lands were called potential wilderness additions.)

How Do We Determine Wilderness Boundaries?

Perhaps the biggest problem was the lack of guidance as to how to determine wilderness boundaries. The lack of clear guidance was evident in several areas.

Definitions: While applying the Wilderness Act and NPS policy to this study, most often the authors found the law and policy too loosely worded to provide enough guidance. Neither policy nor law defines basic terms like "solitude," "untrammeled by man," or "primitive and unconfined recreation." Also, neither gives guidance on determining wilderness boundaries.

Solitude: Solitude from what? When is solitude achieved in terms of user experience or physiography? What are the elements that make up solitude? Are there opportunities for solitude on open flats or broken lava fields (with few trees) adjacent to roads? How do developed areas affect solitude? Where do wilderness users begin to experience solitude and how is it measured – when they are out of sight of roads, or sound of vehicles, or both?

In heavily vegetated areas it seems easier to identify where a sense of solitude begins, but human perceptions vary through time, geographic area, and by individual. The recreation opportunity spectrum (ROS), developed by the USFS and adopted by BLM, was a valuable tool and helped with this identification.

Primitive and unconfined recreation: What is primitive in terms of trail standards and other wilderness developments? Does unconfined mean that management cannot take any confining actions such as gating caves to reduce resource impacts or closing areas that may be hazardous for visitors? How is unconfined reconciled with American Indian access issues?

On one hand, dealing with primitive and unconfined recreation wasn't as complex: El Malpais has no major developments. On the other hand, there are no established visitor use patterns or public use needs either. What demands on the resource and management will future visitation bring? There are no direct baseline data to model, so the GMP team used other parks similar to El Malpais to project overall visitation trends. This wasn't much help in wilderness planning. Visitation levels affect the quality of wilderness. What developments/facilities are necessary to protect the resource and accommodate an estimated potential annual visitation of 276,100 by the year 2000 without compromising wilderness values? Where and how do we provide for the enjoyment of those visitors and maintain wilderness? Again, an ROS system helped to provide a framework.

Untrammeled by man: Currently, there are many private inholdings in the northwestern quarter of the monument; access must be provided and developments will continue. What is the resiliency of this land and environment to the effects of people? How much restoration can we economically and realistically do to give the feeling of "untrammeled by man" (not to mention woman)?

Multiple Problems with Existing Ways Of Determining Wilderness Boundaries

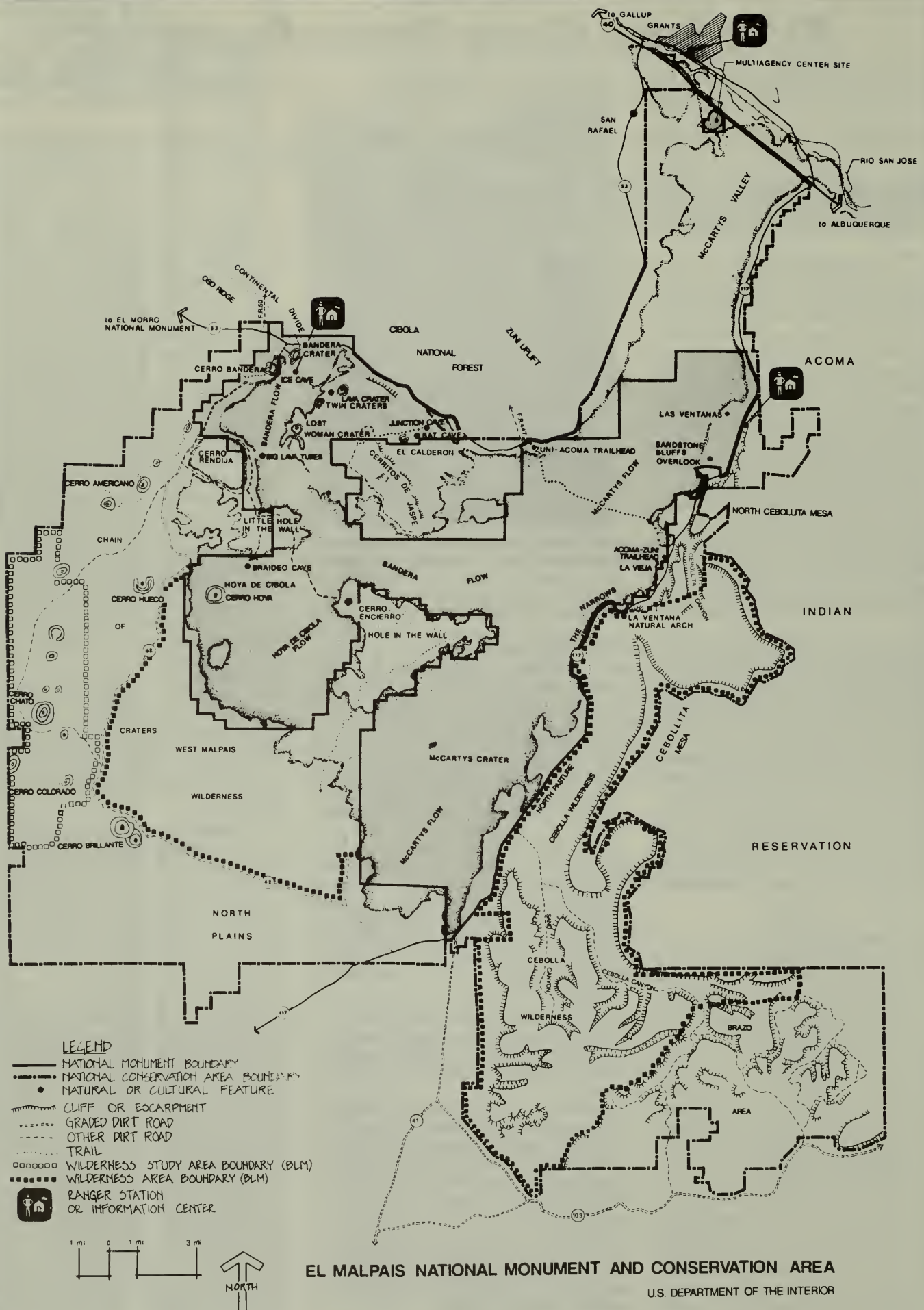
Basically, there are three broad parameters or methods for determining wilderness boundaries:

(1) *Using standard setbacks* (BLM's preferred method). For NPS this method already presents a problem ... the Park Service does not define a standard setback. (At least one NPS study, Big Bend, used a 660' setback from developments). In general, this method provides for maximum acreage, although it is inflexible to terrain and vegetation variations. With standard setbacks (a) solitude and law enforcement trespass problems are created in open terrain; (b) future options for road realignments for safety factors (landslides, floods, etc.) are limited to a narrow corridor, which often creates more expensive realignments than might have been necessary; and (c) options for developing facilities to access wilderness (parking, trailheads, etc.) are much more limited.

(2) *Using physiographic boundaries:* This is apparently the favored NPS method, judging from past studies. This method works well where landforms provide identifiable boundaries. The public can easily identify and understand the boundary, and management can easily enforce and maintain the boundary. Where landforms are indistinct, this method presents problems.

(3) *Using surveyed boundaries:* This method may

(Continued on pages 4 and 5)



EL MALPAIS NATIONAL MONUMENT AND CONSERVATION AREA

U.S. DEPARTMENT OF THE INTERIOR

El Malpais Wilderness Study Poses Problems

(Continued from page 3)

follow section lines, Universal Transverse Mercator (UTM) coordinates, or other artificial lines. This seems to be the NPS and BLM second favorite method. Acreages are easy to calculate and areas are easy to establish on maps, but they also are incredibly difficult for visitors (and managers) to locate on the ground without intrusive signs. Also, surveyed boundaries are expensive to establish formally.

Conclusions and Proposals

The NPS planning team studied BLM's resource and management problems that related to using standard setbacks from roads, looked to other NPS wilderness documents, and looked at issues at other NPS wilderness areas. The approach that seemed most closely to follow past NPS practice was the use of physiographic boundaries where possible and practical, and survey lines where physiography could not be used. Every attempt was made by the NPS team to define manageable boundaries that could easily be identified on the ground. Boundaries were drawn that (1) maximized wilderness values and met other legislative requirements, (2) made maximum use of physical boundaries for ease in public identification and management, (3) prevented potential problems of ORV and other trespass, and (4) enhanced long-term management. In other words, all three methods were used in the NPS El Malpais wilderness study – BLM standard setbacks from most roads, physiographic boundaries where they reflected wilderness criteria, and surveyed boundaries in remote areas where lava flows could not be used.

Approximately 97,025 acres (86,011 instant; 11,014 potential additions) or almost 85 percent of the monument was found to possess wilderness characteristics and values, including most of the major lava flows and ecotones and grasslands adjacent to the lava flows and especially land adjoining BLM wilderness (forming a 136,625-acre NPS/BLM wilderness area). Approximately 17,823 acres in 14 separate monument areas were not suitable for wilderness due to proposed development access routes, and other effects of people. In accord with NPS ***Management Policies,*** once the suitability study was approved, the monument began managing those lands as wilderness.

If policy and guidelines such as NPS ***Management Policies*** and the ***Planning Process Guideline*** (NPS-2) defined the broad parameters of acceptable means/methods for determining wilderness boundaries and had definitions for setbacks, solitude, and primitive and unconfined recreation (two of the three major terms in the Wilderness Act), some of the aforementioned problems could be avoided. Defining wilderness boundaries for those 40 linear miles would have gone just as smoothly as the defining of boundaries for the rest of the monument. However, because of the lack of clear guidance, an unnecessarily large amount of time and effort were spent defining and justifying the wilderness boundary for those 40 miles.

Mabery is Chief Ranger at El Malpais NM; Kenney is a Natural Resource Planner at the Denver Service Center.

Caves and the NPS

By Ronal Kerbo

The U.S. National Park Service has the responsibility to manage more than 350 units, which include historic, cultural, recreational, and natural areas. Within natural areas are seven units that have been designated specifically to protect caves. However, well over 50 other units contain caves and cave systems that must be considered as integral segments of overall management schemes. Examples include Grand Canyon NP (which contains more known caves than any other park in the System); Ozark National Scenic Riverway, with many caves important to the regional hydrological system; and Hawaii Volcanoes NP, where large lava tube systems exist that are important cultural resource sites and that still serve as religious shrines for the Hawaiian people.

Each park must have a general management plan with a section that deals with management of natural resources, which may include caves or other karst features. In the past it was difficult for managers to think of caves, except as possible hazards to the public's wellbeing. Because of perceived difficulty in accessing caves, and the misunderstanding of their importance and relevance to ecosystems, they were not often thought of as assets except in those cases where they could be developed for general public entry. Only developed caves were managed with any degree of great concern, and most of that was aimed at personal safety and allowing the visiting public close proximity to major scenic features.

Misplaced Facilities

Even with these concerns for ready accessibility, many of the developed caves suffered from a management style that was inadequate for the longterm protection of the cave resources. An example is the large number of facilities that exist over such caves as Mammoth and Carlsbad Cavern. These facilities most often provide for visitor comfort and safety, NPS administration offices, and employee residences. The most important concerns here are the attendant gas and sewer lines that may overlie cave passages. With the passage of time, buried lines and fuel tanks located over caves can result in negative impacts. Leaks from any of these sources can go undetected for months, perhaps years. Legislation has been introduced to deal with underground fuel tanks, and parks have been taking critical looks at lines running in close proximity to caves.

A number of recent events have had, and will continue to have, positive effects on cave management. Within the last decade most of the major cave parks have either begun drafting cave management plans or already have approved such plans. As an example, Carlsbad Caverns NP's cave management plan addresses the following topics: cave permit programs; visitor use monitoring; resource protection techniques; and such items as cave gates, maintenance standards, research guidelines, and exploration guidelines. Other items included in separate action plans for specific caves, cover survey standards, disposal of bodily wastes, route marking, and concern for surface or subsurface activities that might directly impact natural systems.

Other important and positive actions relevant to caves include the passage of the Federal Cave Resources Protecton Act in October 1988. This Act states that caves on Federal lands are an invaluable and irreplaceable part of the nation's natural heritage. Caves also are addressed in the recently drafted NPS Resource Management Guidelines (NPS 77). Other provisions for cave management include the Wilderness Act, the Management Policies of the NPS, and the Endangered Species Act.

New Mexico Initiatives

The most recent step taken to insure a legitimate and positive image for caves in the scientific community was the passage of an act to conduct certain studies in the State of New Mexico, which, under Title 11 of the Act, provides for establishment of a Cave Research Institute and a Cave Research Program, both to be administered by the National Park Service, but not limited in its scope to that agency or lands under its jurisdiction.

This Institute and Program would allow for addressing such research topics as modern and paleo groundwater movement through carbonate rocks, the monitoring of global climate change, environmental monitoring, strategies for the recovery of oil and gas reserves, biological and microbiological community relationships, and the protection of subterranean resources from possible intrusion by oil and gas production leaks. The Institute could become the repository and exchange agency for worldwide speleological baseline data.

As sensitivity to and understanding of spelean resources continue to expand, perhaps we can prevent such things as the changing of cave airflow patterns, drastic modifications to a cave's microclimate, the alteration of surface water flow patterns in karst regions, the blocking or pollution of water infiltration routes, the introduction of foreign and harmful elements into a cave, disturbance of cave biota, and altering of natural cave ecosystems. Caves may finally come to be considered in their proper perspective – as an integral part of our land management mandate and ethic.

Educating the Public

The Cave Institute and Program could also play a vital role in educating the general public about the importance of caves and karstic landforms. It could afford the opportunity to investigate the cave environment, and provide educational tools for learning more about bats, other cave fauna, paleontology (many caves act as natural traps), and hydrology (dye tracing of karstic water courses has been a valuable tool in protecting park areas from the negative impacts of poorly placed landfills). The Program also could introduce people to other programs where speleological and karst research are being used to assist in the management of public and private lands.

Another important function of caves that could be explored through the Cave Research Program is their use as natural laboratories where paleoclimatic evidence has been stored, awaiting our discovery. The Grand Canyon packrat middens in caves have yielded pollen up to 4000 years old. The dry, dusty caves of the west side of Guadalupe Mountains NP have been great storehouses of pollen and sloth dung. Coring carefully selected speleothems in Carlsbad Cavern has given up indicators of paleomagnetics and paleoclimatic conditions. In the Devils Hole, a submerged cave system in Death Valley National Monument, researchers have produced a regional paleoclimate record by sampling travertine from the cave.

A last item that has enhanced the image of caves in the National Park System, has been recent discoveries

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Mapping Jewel Cave – From the Surface

By Arthur L. Lange and Mike Wiles

Natural caves are extremely sensitive to disturbances of the ground surface and drainage. Cave resources are subject to destruction by blasting, and alterations in the percolating water supply can affect the development of speleothems and other structures. Even more susceptible to influence is the unique subterranean biota, whose survival can be endangered by changes in cave temperature and moisture. Thus, in planning new roads, buildings, wells, and waste facilities, it is important to ensure that an underlying cavern environment will not be jeopardized.

Toward this end, we tested a promising geophysical technique in Jewel Cave National Monument (JCNM) – a technique that could assess the possible existence of undiscovered caverns beneath a proposed construction area. Earlier surveys using the natural-potential (N-P) method had demonstrated its effectiveness in areas of low relief; the much more severe terrain of the Black Hills provided an especially rigorous test of this procedure.

Geologic and Hydrologic Background

JCNM is situated 21 km west of Custer, SD. The known cave – over 132 km (82 miles) – lies beneath a 5 km2 area (2 land sections) of a broad plateau, dissected by steep-walled Lithograph and Hell Canyons (Fig. 1). Average elevation is 1600 meters (5200 feet), with about 120 m of relief. Hilltops form broad, flat meadows, while the slopes are typically forested with Ponderosa pine. Neither canyon maintains a stream flow, even during the heaviest rains.

The cave-bearing formation is a buff, massive dolomitic limestone (Pahasapa of Mississippian age), about 120 m thick. Unconformably overlying this unit is the lower third of the Pennsylvanian Minnelusa formation, containing 60 m of red sandstone, limestone, and thin beds of chert and shale. Both units occupy the vadose zone.

Jewel Cave is a 3-dimensional rectilinear maze (Fig. 2) of phreatic origin (pertaining to that layer of rock or soil through which water may enter wells or from which springs and seeps may emerge). Its 5 distinct levels have developed generally within the upper half of the limestone. Most of the known passages lie beneath the Minnelusa cap and are completely dry. The Minnelusa apparently prevents or retards direct seepage of rain and snow melt. Erosion has removed the Minnelusa from portions of Hell and Lithograph Canyons, exposing the Pahasapa. Galleries beneath these areas usually are dry, though dripstone testifies to past infiltration. Present-day seepage is occasional, sporadic, and extremely localized. Most water enters the cave in areas directly below the contact of the Pahasapa and Minnelusa. There, dripping generally occurs year round, although drip rates vary seasonally.



Figure 1. Reading the natural potential on a slope of Hell Canyon directly outside the natural portal of Jewel Cave.

Natural-Potential Phenomena

Just as our atmosphere everywhere is filled with invisible electromagnetic waves – from radio and TV broadcasts as well as emissions of our sun and stars, so the ground contains both a.c. and d.c. electric currents. Electromagnetic signals generated by worldwide lightning and solar storms penetrate the ground to depths dependent on their frequencies.

Likewise, d.c. currents circulate through the ground from causes as diverse as chemical reactions around mineral deposits, volcanic heating, and moving groundwater. The individual sources form an assemblage of "geo-batteries" of all different sizes and orientations. The natural-potential method measures the voltages generated by these currents along surface profiles, using a roving electrode tied through a long cable and meter to a fixed base electrode.

At this point, one might wonder how a cave can produce a battery-like current. Actually there are several ways a cave can affect the natural electrical environment. In one of these, an empty cave gallery provides a locally more permeable path for infiltrating water, with the result that greater infiltration occurs over the cave roof than the surrounding rock. Because of the electrokinetic, or streaming, phenomenon (Ishido and Mizutani, 1981), the cave ceiling becomes positively charged relative to the ground surface, while the surface zone overlying the cavern becomes more negatively charged than its surroundings (when the fluid chemistry is basic). Thus, a negative potential anomaly develops locally over the cavern (Lange and Quinlan, 1988). In Jewel Cave, where drippage pH averaged 8.35 (Bakalowicz et al. 1987), the cave ceiling measured almost 250 millivolts (mV) more positive than its corresponding point on the surface, 40 m overhead.

Because the voltage anomalies observed over caverns can be small – on the order of 5 to 50mV, meticulous data collection procedures and precision instrumentation are required. The end result is a computer-drawn graph of voltage and elevation vs. horizontal distance along each profile (Fig.3) and where lines are closely spaced, a plan map of potential contours.

The Jewel Cave Survey

Prior to using any geophysical method as an exploration tool for extending a cavern system beyond its known limits, one should test the method over at least one mapped passage, to see whether the technique can resolve the underlying void. Fortunately, at Jewel Cave a detailed map of the system was available, and passage depths had been established. Thus, four lines, ranging up to 840 m in length, were laid out in a NNE direction so as to cross the "grain" of the maze at nearly right angles (Fig.2).

Representative portions and depths of cave system were selected. On each line, a base station was established near a road, and a long, color-calibrated wire was spooled out to the ends of the line. Multiple potential readings were made at station intervals ranging from I to 7.5 m, as data warranted, and corrections were made to remove drift due to temperature fluctuations in the soil and electrodes (Fig.1).

Jewel Cave Anomalies

Definitive negative anomalies coincided with the cave passages, wherever the test lines crossed over cave passages. Line B is typical of this correlation (Fig.3). Here, the edges of the broad central low response correspond to the north/south limits of the mapped cave. Except for the northern ends of the profile, the remainder of the line is positive. The exception occurs around the main highway junction, where a nearly east/west fault crosses the line (Deal, 1962). Although N-P expressions of faults are common, it also is possible that additional undiscovered cave galleries underlie this feature.

It is instructive to ask what would be the result of placing a drilling target over the maximum negative value of the profile. On Line B, such a drill hole would intercept a major lower level of the cave system at an estimated depth of 140 m.

The three other profiles likewise showed a definitive correlation of millivolt lows with mapped cavern. As on Line B, negative readings also expressed fault zones. All in all, the natural-potential profiles delineated more than 90 percent of the mapped cavern crossed by the lines. As mentioned above in the section on hydrology, much of the cave today remains dry, suggesting that mechanisms other than downward filtration are contributing to the anomalies observed over the cavern.

Exploration Scenario

In practice, one would not necessarily target a test hole on the negative peak. For one thing, the N-P response can express voids situated on either side of the line. In order to better resolve the target, several short potential lines would be run offset from the first to

Caves and the NPS

(Continued from page 5)

in Lechuguilla Cave, within Carlsbad Caverns NP. Scientists within the NPS, the USGS, other government agencies, and the private sector, are excited about the possibilities of using the cave to gather baseline data that will give us new insights into global warming theories. The passage leading into the major portions of the cave was blocked with loosely compacted rubble for perhaps many thousands of years. Now, recent explorations have led explorers and scientists "through the looking glass" into a world that has been relatively unaffected by the impacts of 20th Century life ... a real wonderland, where even Alice hasn't been.

Kerbo is Southwest Regional Cave Specialist. He was formerly Cave Specialist at Carlsbad Caverns NP.

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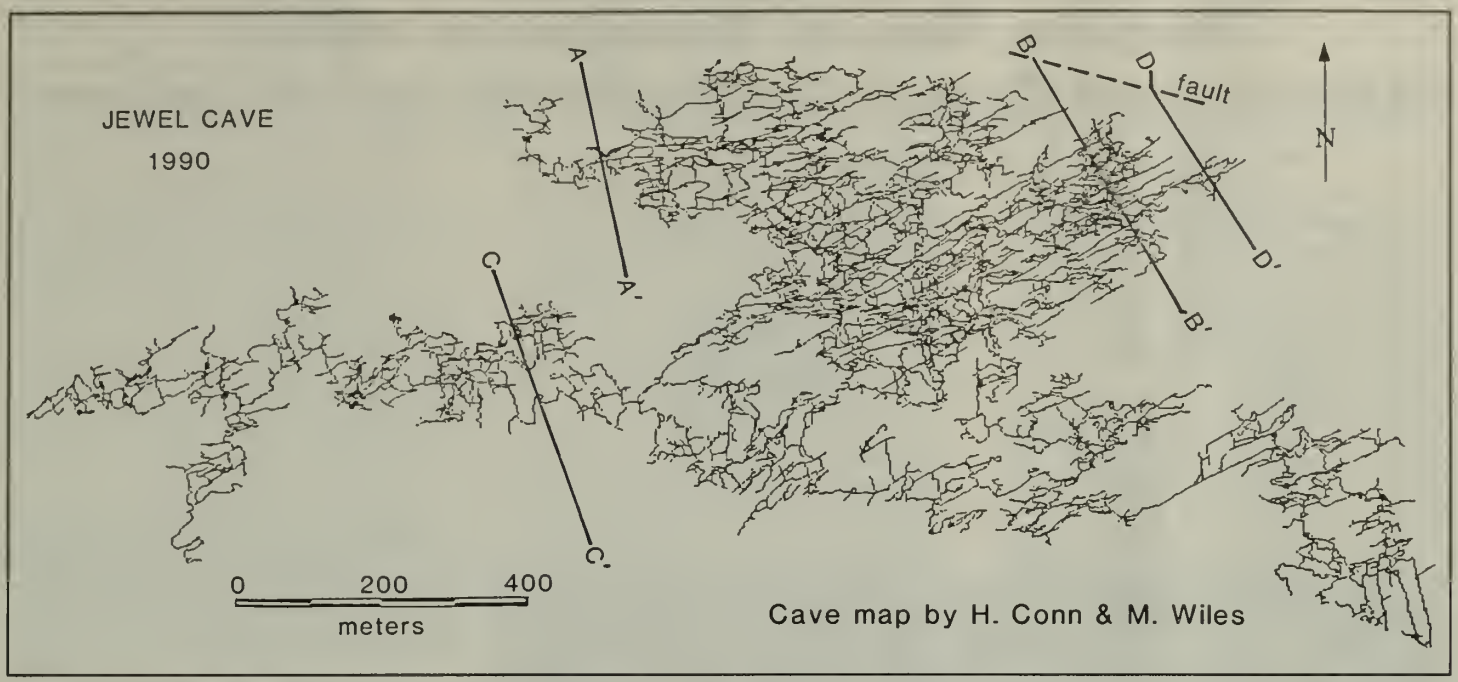


Figure 2. Computer-drawn map of the known 132-km extent of the Jewel Cave labyrinth, showing the natural-potential lines and a segment of a major fault that intercepts two of the lines.

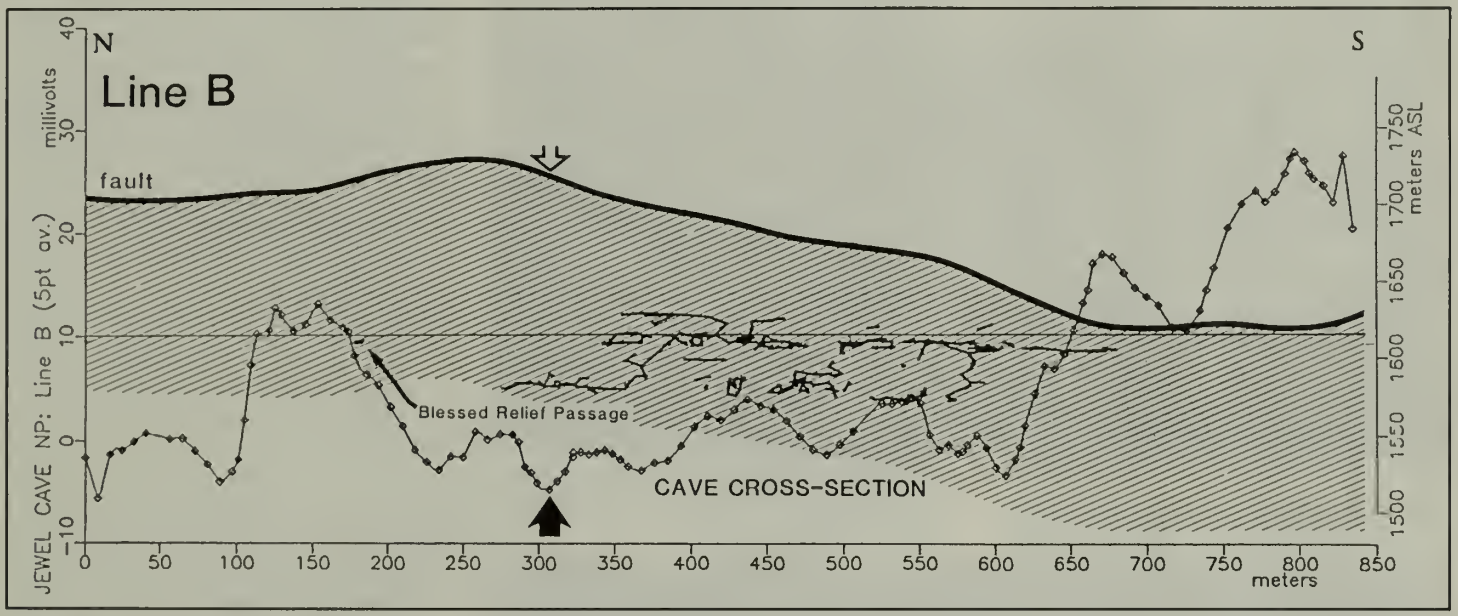


Figure 3. Natural-potential profile of Line B superimposed on a cross section of topography and cave. The major N-P low coincides closely with the region of mapped cave; a secondary low is associated with a major fault zone, which may possibly contain voids. A drill hole sighted at the open arrow, corresponding to the lowest potential value of the line (solid arrow), would intercept a cave passage at a depth of about 140 m (~460 ft).

map the response on either side.

Because N-P anomalies, both positive and negative, can arise from processes other than water movement around voids, it is advisable to test the N-P targets by means of another geophysical method. The gravity method is most appropriate since it responds directly to low density zones and voids underground (Neumann, 1967). Unfortunately, the method requires precise surveying of ground elevations, and mapping of nearby topography. In addition, it loses resolution as the target depth exceeds the width of the void, so that the deeper passages may not be resolvable. For these reasons, one would confine the gravity measurements to the N-P target zones, rather than attempting to sample the entire area.

Other Natural-Potential Tests Over Caves

The senior author began applying N-P techniques to caves in 1986 over the Ozark Underground Laboratory, Protem, MO. Three test lines produced a strong correlation of negative anomalies with mapped cavern. Since that first trial, tests have been made in environments as diverse as the Mammoth Cave area in Kentucky (Lange and Quinlan, 1988), the Edwards aquifer of Texas, the Great Basin of eastern Nevada and desert outcrop of Kartchner Caverns State Park, AZ (Lange et al., 1990). Especially pronounced anomalies have been observed over underground streams, making "natural-potential" the logical targeting tool for siting monitor wells over groundwater conduits in carbonate terrains. Ongoing research is focusing on the electrochemical processes that generate cavern anomalies.

The Jewel Cave N-P study was funded by the University of Wyoming National Park Research Center and JCNM and conducted by The Geophysics Group in conjunction with San Diego State U. Foundation.

Lange is a geophysicist with the San Diego State University Foundation; Wiles is a JCNM Park Ranger.

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Reclamation of Abandoned Mines At New River Gorge, Gauley River, and Bluestone

By Carol A. Pollio

"Smokeless" coal from the New River Gorge once fueled the navies and steamships of the world. America's steelmills and industries depended on this clean burning coal to meet their energy needs. Today, all that remains of this industrial heritage is an abundance of abandoned mine sites, including hundreds of mine openings, refuse piles, deteriorating structures, and dangerous highwalls.

The National Park Service administers three units in southeastern West Virginia: New River Gorge National River (NR), Gauley River National Recreation Area (NRA), and Bluestone National Scenic River (NSR). This part of West Virginia was mined extensively in the past – for coal in the New and Gauley River areas, and for oil and gas near the Bluestone and Gauley Rivers. This past mining activity created a wide range of safety and environmental problems, which NPS managers must now address.

Abandoned underground mines have serious potential health and safety hazards and environmental problems in New River Gorge NR and Gauley River NRA. The greatest threat is from open or partially open mine portals (entries), especially those mined out areas that are extremely unstable and easily accessible to park visitors and area residents.

Because of the geologic formation of coal seams in this part of West Virginia, coal was primarily "deep mined." (Diagram 1). Deep mine portals present serious hazards to visitors, including the danger of roof falls (loose, falling rock), the presence of poisonous and explosive gases (methane), and deep pools of water. In addition, numerous partially collapsed buildings and unstable walls, conveyors, rail lines, bridges, hazardous equipment, and debris are associated with deep mines. Specific environmental problems that go with underground mines include mine drainage, subsidence of mine voids (creating sink-holes), and unvegetated, eroding mounds of waste materials and coal refuse.

Unreclaimed surface mines are a source of significant landscape disturbances in all three of the NPS areas. Hundreds of acres of unvegetated or partially vegetated bench areas with steep unstable spoils piles and slides subject to slippage and erosion still remain. Major associated problems include erosion and runoff from highwalls, haulroad and spoil areas, rock falls, slippage and slope failures, and lack of vegetation on many sites.

In addition, many reclaimed surface mines within park boundaries present problems. Surface mines, reclaimed as contemporary standards require, are often returned to grasslands, creating areas devoid of woody vegetation surrounded by climax forest. Typical reclamation seed mixtures often contain species of grasses, e.g. rye, now known to be allelopathic (plants which produce toxins that prevent other plants from becoming established.)

Other types of abandoned mine sites in the three park units include oil and gas operations – capped wells and clear areas with sparse vegetation. The Bluestone NSR contains the bulk of these abandoned operations.

In 1988, an inventory of abandoned mine lands (AML Inventory) was conducted through a Cooperative Agreement with West Virginia University (Armstrong and Yuill, 1988). Potential abandoned mine sites were identified first by conducting thorough searches of historical geological data; historical aerial photos; USGS topographic maps; coal, oil, and gas permit and exploration records, and numerous interviews with state and local experts. The most difficult task was ground truthing the sites. The New River Gorge, often referred to as the Grand Canyon of the East, contains rugged terrain and few access roads. The gorge walls are steep, in some places rising 1500 feet from river edge to ridge top in as little as 100 yards.

The AML Inventory revealed 115 areas with abandoned mines located in the park or within a 1/2 mile of the boundary. Each abandoned mine may contain numerous hazards, including multiple open portals, deteriorating structures, and scattered debris. Once located, the sites were rated to determine which ones presented the most serious problems, using the following hazard rating system.

Health and Safety

High – likely danger to exposed visitors/residents including features such as portals, unstable structures, subsidence holes, dangerous equipment.

Medium – moderate potential for hazard if site is visited – structures, unstable highwalls, slides, partially accessible portals.

Low – potential for hazard but low likelihood based on site conditions – unstable trail, low highwall, etc.

None – minimal or no hazard potential observed.

Environmental

High – observed significant problem including active slides, major polluted drainage discharges, etc.

Medium – high potential for significant future problems – unstable slide areas, impounded water in unstable areas or moderate problems observed such as erosion and sedimentation.

Low – minor problems identified such as minor drainage with no visual evidence of pollution or limited erosion and sedimentation.

None – no problems observed with minimal potential for future problems.

Eyesores

Identified based on qualitative judgments in the field. Unvegetated slides, refuse areas, dead vegetation, coal piles and trash and debris were examples of areas noted in this category. The visibility of mine features from the river, trails, and major and minor roads also was estimated and described.

Site Accessibility

Ease of access (vehicle, pedestrian, difficult pedestrian) and site visitation levels (based on physical evidence, such as tire tracks, road use, trash, and personal interviews) were rated and described.

In addition, the Office of Surface Mining Reclamation Priority System was used. It categorizes sites into six levels that determine priorities for reclamation: Priority 1 represents a threat of substantial physical harm to

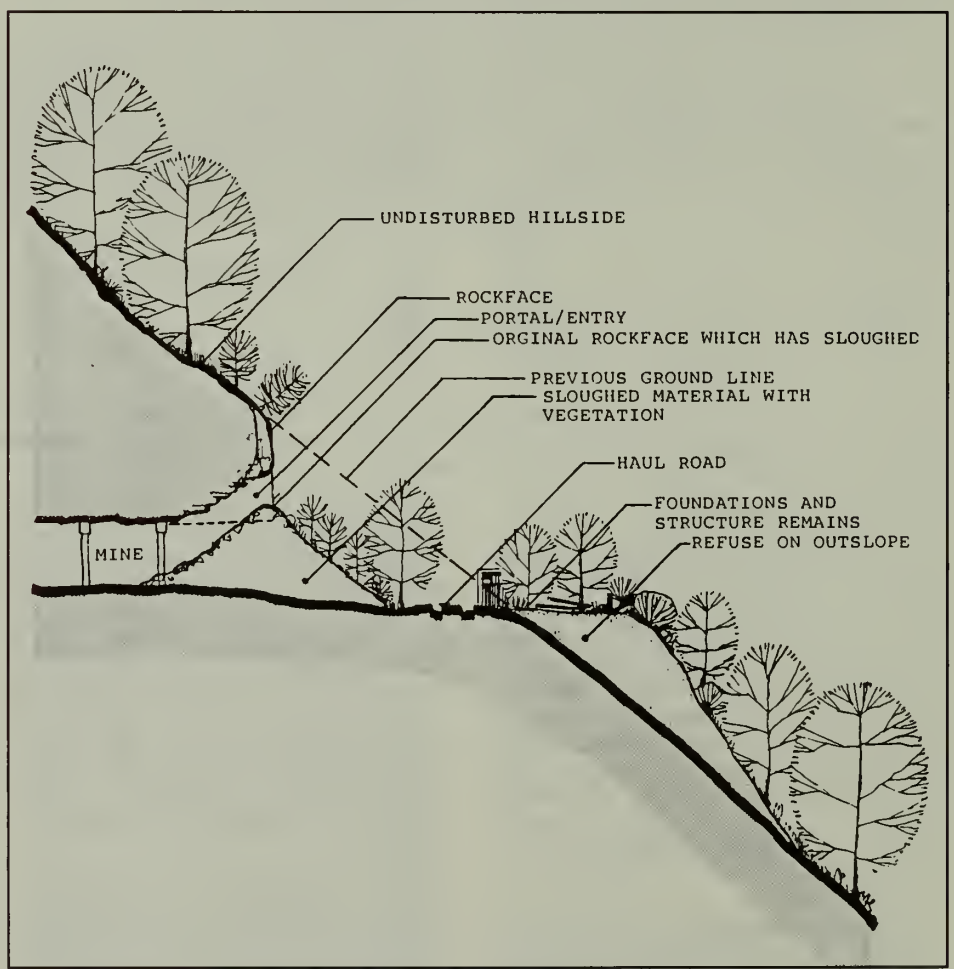


Diagram 1. *Typical Abandoned Deep Mine Site*

Abandoned Mines

(Continued from page 8)

the public; Priority 2 is the protection of the public from adverse effects of mining practices; Priority 3 deals with restoring environmental damage; Priority 4 represents research project areas for reclamation techniques; Priority 5 deals with repair or replacement of public facilities, such as roads, utilities, or recreation areas adversely affected by mine operations; and Priority 6 deals with public lands adversely affected by coal mining. During the inventory, numerous sites were categorized as Priorities 1, 2, and 3. (USDI Abandoned Mine Update)..

Using this rating system, 62 sites were identified as possessing severe potential health and safety problems, 31 were rated moderately severe, and only 22 received a low or no-hazard rating. Environmental problems were considered severe at only 3 mine sites; another 38 sites were rated moderately severe, and 31 sites were categorized as eyesores (Table 1).

The information gathered was then rated a second time to establish priorities for reclamation. The most critical potential health and safety hazards were determined in terms of:

1. Problem Severity – the most severe health and safety and environmental problems; and

2. Area Sensitivity – potential impacts on present or planned park developments.

The ultimate goal of the AML Inventory at New River Gorge NR was to establish a priority list of sites in need of reclamation. The Surface Mining and Reclamation Act, passed in 1977, required reclamation of existing mining operations and created a fund source for the reclamation of mines abandoned prior to passage of the Act. This funding, administered by the Office of Surface Mining, has been used to reclaim 5 of the worst areas identified. To date, 50 mine portals have been closed, 3 mine structures have been fenced off, 600 feet of highwalls have been filled, and a large landslide area has been stabilized.

The reclamation projects, coordinated through New River Gorge NR Resource Management section, were designed carefully, taking into account federal threatened and endangered species, state rare and endangered species, wetlands considerations, wildlife habitat, and the significance of cultural resources at the mines. An independent threatened and endangered species (T&E) study was done by the West Virginia DNR to determine the presence of potential habitat of such species, although it focused primarily on bat habitat (Bryan 1988). The park Cultural Resource Specialist coordinated with the West Virginia State Historic Preservation Office to ensure Section 106 compliance. Using this information, 3 types of mine closures were developed that minimized the impact of mine closures on park natural and cultural resources.

The first was a simple soil closure, where soil was backfilled into an opening and a corrugated pipe was placed at ground level to allow for Eastern woodrat (*Neotoma floridana magister*) access. The Eastern woodrat, while still fairly common in West Virginia, is being considered for threatened status in Pennsylvania due to population declines.

The second type of closure consisted of steel bars anchored in surrounding rock – wide enough for bat access yet narrow enough to exclude people. The T&E survey had indicated the presence of bats (*Pipistrellus subflavus* Eastern pipistrelles, *Myotis lucifugus* Little brown bats, and *Epesicus fuscus* Big brown bats) in

(Continued on page 10)

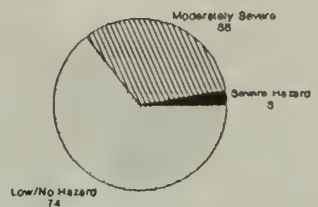
Table 1.

New River Gorge National River
Abandoned Mine Inventory

Health and Safety
Hazards Associated with Mines



Environmental
Hazards of Mines





***Resource Management Ranger** Robert Sullivan looks into the main portal at the Ames Mine, scheduled to be reclaimed this year. Photo by Robert Sullivan.*



Open portal at Ames Mine. Photo by Robert Sullivan.

Reclamation of Abandoned Mines in West Virginia

(Continued from page 9)

several mine openings that were a top reclamation priority. The study also identified portals that represented good potential habitat for federally endangered species, such as the Indiana bat (*Myotis sodalis*) and Virginia big-eared bat (*Plecotus townsendii virginianus*). Each of these steel closures, known as "bat gates," was custom made to fit individual mine openings securely.

The last type of mine closure was designed to allow for its possible removal at a later date. It consisted of a foam plug, blown into the opening and then covered with soil. The mine openings where this closure was used were the main portals of the Kaymoor Mine, one of the finest examples of an old coal mine and town in the entire gorge. A foam closure allows management the option of removing the plug when the site is developed, so that visitors will be able to experience the operation of a historic coal mine.

As long as funding is available, more cooperative projects with the Office of Surface Mining will be planned. Of the remaining abandoned mines in New River Gorge, 5 rated as most hazardous to both visitors and the environment would then be reclaimed.

Native Seed Banking

The New River Gorge NR staff also has undertaken the task of reclaiming some of the smaller disturbed sites using an experimental process known as native seed banking. This process involves covering disturbed areas, such as coal refuse piles, with lime, fertilizer, and a 2-inch layer of soil taken from the forest floor. This encourages the germination of native species. Three replications of 20' x 20' experimental plots have been established on a large coal refuse pile near the abandoned Brooklyn mine site. The plots were installed in June, August, October, and the following year's June, to determine if time of year is linked to emergence of desirable species.

In August, Resource Management rangers identified all vegetation on the plots and currently are preparing a formal report for the native seed bank project. Initial data indicate that woody species present are primarily native species, having successfully crowded out some invasive non-natives. Herbaceous species present are a mix of both native and non-native species with very few takeover species present. On an annual basis, resource management staff will return to the site and monitor successional changes in vegetation to determine success over time.



***Natural Resource Specialist** Margaret Weesner looks at a "bat gate" installed at the now reclaimed Kaymoor Mine. Photo by Margaret Weesner.*



***Deteriorating stone wall** from the Ames Mine site. Photo by Robert Sullivan.*



***Deteriorating structure** hides a large, 6' x 10' open portal. Photo by Robert Sullivan.*

It may be many years before all the scars that remain from mining of the Gorge are healed, but the Abandoned Mine Land Inventory for New River represents an excellent start in speeding the process. This year the Office of Surface Mining has awarded the park $50,000 to conduct identical surveys on the Gauley River NRA and Bluestone NSR, two areas added in 1988 and administered by New River Gorge NR. NPS Resource Management personnel will identify and prioritize abandoned coal, oil, and gas operations along the Gauley and Bluestone Rivers and will include a T&E species study of the sites inventoried. Results will be used to determine funding levels necessary to reclaim abandoned mine sites within the Gauley River NRA and Bluestone NSR.

In our search to make a safe and enjoyable experience for park visitors, it is important not to overlook the cultural history and significance of these areas. Abandoned coal mining towns, like Kaymoor and Nuttalburg, are considered by many to be invaluable vestiges of Appalachian heritage. As they are reclaimed, many historic features of these sites will be preserved for visitors to discover and explore ... safely.

Pollio is Natural Resource Specialist at New River Gorge NR.

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New Perspectives in Science

By William E. Brown

Editor's Note: The following essay appeared first in ***Proceedings*** *of the Second Glacier Bay Science Symposium, Sept. 19-22, 1988 and is here reprinted with permission of the author and of Jim Wood,* ***Proceedings*** *co-editor. Brown is currently SWR Coordinator of the Columbus Quincentenary, stationed in the Santa Fe SWRO. He plans to retire in April 1991 and devote himself to the activitiess of the Glacier Bay NP Science Advisory Board and the Friends of Glacier Bay... all from the rocking chair on the front porch of his home at Gustavus, AK.*

In the beginning, the national parks were anthropocentric. When Phineas T. Barnum visited Yosemite in 1870, he conveyed the sense of the age with this comment:

"Unsurpassed and unsurpassable. Look around with pleasure and upward with gratitude."

A century later, the founding anthropocentric purpose still informed the creed of lifetime ranger Lon Garrison – with the added insights of a century:

"Parks are for the understanding of nature and ourselves; they are for the inspiration that comes from lonely commune with nature and the forces that shape our environment; they are for solace for those troubled by the turbulence of modern civilization."

From this modern turbulence, with its specter of human species run amok, emerged a biocentric reaction; that nature – particularly in those last untrammeled vestiges of it, the national parks – was intrinsically valuable, independent of conventional measures of human utility. In its most profound statement this philosophy maintained that plants, animals, and mountains had rights and souls of their own. This was a Deep Ecology version of the pantheism and spiritual union with nature that once moved us all. It called back to Eden, to the garden before its violation, to the human innocence and integration that preceded the violation.

The founding ideal of the National Park Service can be viewed as a three-part esthetic: The Wonders of Nature, in both its emotive and intellectual beauties; the health and virility gained from wildlands experience, the Rooseveltian perpetuation of the frontier mythos; and the pure esthetics of artistic and literary expression. Somehow, in the crush of the late 20th Century, that ideal had become inadequate. The environmental ethic had crept in.

While public thought and perception evolved, the people of the Park Service doggedly pursued the management of their congressionally mandated dilemma: preservation and use ... without impairment. But they began to see that parks were more than the pleasuring grounds and mythic landscapes of the founders' vision. For the environmental ethic was contagious. They began to view parks as laboratories and models whence that ethic could be broadcast to the larger society. They began to see that parks could not long endure as refuges from troublous times and encroaching despoliation, lacking public conversion to the environmental ethic.

On another front, as early as the late 1920s, with the advent of George Wright's influence, the Park Service began to glimpse the need for science-based management if these marvelous areas were to be preserved. But the Depression, Wright's untimely death, wars, then postwar expansion of the Park System and the deluge of visitors to it, and the Park Service's response

In the long view of history, what can be attributed only to an accident of cultural altruism – this setting aside of parklands for the benefit of the people – has become a pragmatic treasure of the utmost current significance.

to that deluge, combined to shrivel the enlightened beginning. Then came criticism of the hiatus in park science, followed by a series of studies beginning with the Leopold and Robbins reports of the early 1960s, all calling for order-of-magnitude expansions of scientific research in the parks, and for the sake of their own preservation.

Social studies began to make the tie between environmental conditions and human health – physical, mental, social. An earth mortgaged by the parents faced the children yet to come.

Today the expanding horizons of thought have met each other coming around. Now the ecosystem affecting and affected by human beings is clearly seen to be the entire biosphere.

And still, here is the Park Service preserving the natural and cultural environments of the past. In the long view of history, what can be attributed only to an accident of cultural altruism – this setting aside of parklands for the benefit of the people – has become a pragmatic treasure of the utmost current significance. The adventure in cultural edification first embodied in the early parks has held in trust relatively unaltered ecosystems or parts thereof in which, belatedly, we can attempt to discover the workings of this world ... in which we can measure environmental and cultural changes that threaten the environmental solvency and sanity of the world.

From such studies in the parks can come the communications – scientific reports, lectures, campfire and school programs, films – that can inform and move the public at large to those reforms of social and individual behavior that may yet save us, and the parks that give us inspiration.

This traditionalistic institution, which has always fought within itself whether to go along with public demand or to take on the duty of edifying and guiding that demand, has, through its prescient congressional mandate, unwittingly positioned itself and the landscapes it manages for transcendent contribution to this society and the world at large. Its very conservatism, its being a kind of model of cultural lag, finding solace in the past, has fortuitously been its greatest strength. For despite the Service's human foibles, the System stands today relatively intact for the great social purpose of the coming decades. It would seem that social experiments as well as scientific ones can produce unforeseen benefits.

Now opportunity beckons. Through scientific studies using the vast assemblage of natural laboratories preserved by the terms of an earlier vision, the restrictively managed parklands of this Nation – and from that inspiration, of the world – stand ready to synthesize the anthropocentric and biocentric visions so that man can return to the fold as a functioning rather than destructive part of the biosphere. Man in nature, beholden to it for nurture – and reciprocating that care – is no longer an ecofreak.

In this expansion of the meaning and purpose of the National Park System, with its evolving bureaucracy trying to catch up with the evolving world ecosystem, the older mission cannot be lost. Nor indeed should we presume to change the words of the Organic Act that in 1916 launched the Service and cohered the System. In its wisdom, the Congress gave us a broad charter, which, like the Constitution, responds elastically to the needs of an evolving society:

"The Service thus established shall promote and regulate the use of the Federal areas known as national parks, national monuments, and reservations ... by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Immanent in this charge is the authority to meet the necessities of a changing world, to marshal the resources and ideas necessary to save the parks, to build upon the founders' philosophy – as a tree grows and extends its branches in its maturity. We must intelligently explicate the evolving mission and purpose, and seek congressional sanction for the tools and wherewithal to carry them out. But this added nourishment should flow through the roots that have sustained us all these years. This is no new planting. It is the growth of the original institution.

From the beginning the parks have been a mosaic of values and functions. These parks, these cultural creations, can and should – through enlightened zoning and land-use dedication – combine traditional public access to beautiful and instructive parklands with scientific utility for social understanding and survival. Environmental standards and aspirations gained from parkland experiences – along with the scientific knowledge derived from parkland study zones – can help guide the larger decisions and reforms that our society must make in the coming decades.

Thus, the founding concept of public use and enjoyment need only be adaptively expanded to accommodate modern socio-scientific imperatives. To the extent that America's parklands contribute to that larger reform, they can save themselves from encroachment and further justify their value to the public. In a world ever more straitened for resources, the park ideal and the parklands themselves will escape exploitative predation only because of their more profound social utility as parklands.

correction

A clarification is is order for the article "Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report" (***Park Science***, Winter 1991, vol.11(1):14-15). The principal investigator of the social risk assessment reviewed in the article was Dr. Gary E. Machlis, Sociology Project, Cooperative Park Studies Unit, U/ID, Moscow. In addition, Dr. Roger E. Kasperson, Professor of Geography and Director of the Center for Technology, Environment, and Development, Clark University, Worcester, MA, was co-investigator on the project.

Also the institutional association of Seth Tuler was unclear. He is a graduate student in the Environment, Technology, and Society Program at Clark University, Worcester, MA and served as a Research Associate for the University of Idaho CPSU on this project.

regional highlights

Pacific Northwest

Edward Starkey, research biologist with the NPS/CPSU at Oregon State University, has been named by Interior Seretary Manuel Lujan Jr. to the 16-member team charged with developing "a plan that will lead to the conservation and survival of the northern spotted owl." The Secretary told the team to "exercise the full range of its creative abilities" in seeking a plan that would lead to removal of the owl from the threatened species list, but he also directed them to build a plan that would limit job losses in the Pacific Northwest.

The owl, which lives in old-growth conifer forests of the Northwest, was declared a threatened species last June. Proposals to set aside large tracts of public forest land to protect the bird would result in a sharp drop in logging.

Marvin L. Plenert, Pacific regional director of the USFWS, was named team leader. A draft plan is slated for presentation by Dec. 31, 1991. Donald R. Knowles, deputy under-secretary of the Interior and Lujan's representative on the team, said it will take about six months after a draft is released for final adoption of the plan.

* * *

Fender's blue butterfly, a relic of the ice ages and thought to be extinct since 1937, has been rediscovered, living a precarious existence in remote sites of the Willamette Valley, Oregon. A petition is being prepared requesting the USFWS to list the butterfly as threatened under the federal Endangered Species Act. Another native of Oregon – the silverspot butterfly – already is listed as threatened.

The butterfly's brush with near-extinction is linked directly to destruction of the native prairie ecosystems and the one flowering plant vital to the insect's existence, according to Paul Hammond, entomologist and butterfly expert, who discovered the relict population in Oregon State University's experimental forest. Kincaid's lupine is the only acceptable food for the larvae of this butterly, and between agriculture and urbanization, the native prairies that contain the plant have been reduced to one percent of what they once were.

* * *

A North Cascades grizzly bear technical group has been formed to review the research and vegetation mapping efforts that have been on-going in the North Cascades for about five years. The group's charter is to establish the process and criteria for jointly determining the North Cascades' ability to support grizzly bears. The technical group then will make a recommendation to the Northwest Ecosystem Grizzly Bear Management Subcommittee about whether or not the North Cascades is a viable ecosystem for grizzly bear recovery.

The Northwest Ecosystem Grizzly Bear Management Subcommittee reports to the Interagency Grizzly Bear Committee, which will make recommendations to the USFWS.

Bill Gaines, Jon Almack, Dan Davis, Jon Jarvis, Gregg Servheen, Chris Servheen, and Rodd Richardson are members of the technical team. Rick Mace, Richard Knight, Tony Hamilton, and Bruce McLellan are reviewers and Peter Morrison, Jim Eby and Bart Butterfield are advisors.

The National Parks and Conservation Association (NPCA) is working to increase local participation and citizen involvement in park management issues by establishing a Pacific Northwest Regional NPCA office in Seattle, WA. Its director, Dale Crane, has 37 years of parks and conservation experience, the last 12 of which were with the U.S. House of Representatives as professional staff and as Staff Director for the Interior Committee responsible for National Parks and Public Lands policy. Two new members to the NPCA Board of Directors from the Northwest are Dr. John Miles, dean of the Huxley College of Environmental Studies at Western Washington University, and Russell Cahill, former NPS Park Ranger and Director of California State Parks.

Wildlife & Vegetation Division

Projects to be funded uder the FY91 Director's Special Initiatives portion of the Natural Resources Preservation Program (NRPP) were to be selected March 22. Issues emphasized this year are Effects of Urbanization and/or Boundary Development on Park Environments, Management of Animal Populations, and Managing Human-Natural Resource Conflicts and Issues. Of the 66 pre-proposals recived, 15 were selected for full proposals.

* * *

Park biological inventories are a major focus of the I&M program this year and next. First, the gaps in park flora and fauna lists will be assessed. Then a strategy for filling gaps (such as mammals first Systemwide or basic data sets park-by-park) will be devised and implemented. The goal – Phase I of the I&M program – is basic data sets Systemwide within 10 years. The monitoring side of the I&M program is stressing development of pilot park programs. Denny Fenn, Deputy Associate Director, Natural Resources, is overseeing the total I&M program; the Wildlife and Vegetation Division is handling the biological component.

* * *

Pete Comanor, NPS Global Change Coordinator, chaired a meeting of the NPS Global Change Committee in Reno, NV Jan. 29-Feb. 1. (See Global Change Update, this issue).

* * *

The Division is producing various print and audiovisual materials this year. Vol. 27, No. 4 of ***Trends***, guest edited by Mike Ruggiero, came out in January. Titled Preserving Natural Resources, it contains articles by NPS people in natural resource work as well as by Laurie Wayburn of the Point Reyes Bird Observatory.

NPS-77, the Natural Resources Management Guideline, appears headed for spring printing. This has been a huge collective effort of several hundred people, shepherded by Anne Frondorf.

A report on the NPS Recreational Fisheries program, coordinated by Mike Coffey, should be out this summer. A 4-color folder for the public, Endangered Species in the National Parks, was due from the printer in February. Copies were shipped to all regional offices and WASO for further distribution.

The Division also has on the 1991 docket folders on research opportunities in the national parks and the Watchable Wildlife program, as well as an IPM training videotape on rodent management, and workbooks to accompany 5 existing IPM videotapes. The Division also will produce and distribute the 1990 Servicewide Research Inventory this summer and a Servicewide summary of the FY91 RMP update information.

Mike Coffey changed hats on February 11 when he moved into the Science Branch of the WVD as Wildlife Biologist. Part of his former work will be done by a Consumptive Uses Specialist, a position advertised in January.

Rocky Mountain

The Beaver Creek Shelter (39CU779) is a north facing rock shelter in Wind Cave NP. Excavations were conducted by the South Dakota (SD) School of Mines and Technology in 1985 and again by that institution and the SD Archaeological Research Center in 1985 and 1987. This work penetrated 4.77m of vertical rock shelter sediments. The excavations defined 22 stratigraphic horizons, many of which contain archeological materials, and produced a sequence of 12 radiocarbon dates covering most of the Holocene.

The archeological specimens, the stratification, and the radiocarbon dates indicate the shelter has the potential of providing information on the transition from Early to Middle Archaic periods, a poorly known interval in the northern Great Plains, and of elucidating the interrelationship between climatic trends and human prehistory throughout the Holocene.

A report on the archeological remains of the Beaver Creek Shelter has been completed by Lynn Alex. In addition to the archeology, the shelter is important for its nearly complete paleoenvironmental sequence for the Holocene in the Black Hills. The paleofauna, soils, snails, and other environmental indicators have been partially reported in a number of papers and masters' theses.

* * *

Plans by a Golden, CO company to build a hazardous waste incinerator adjacent to Pipe Springs National Monument apparently have been halted. The facility was to be located on the Kaibab-Paiute Indian reservation and was to process 100 to 200 thousand tons of petroleum and related wastes per year. An on-site landfill for the waste ash was to be included. Negotiations came to an impasse over environmental protection measures desired by the Indian tribe. The NPS was concerned about potential effects on air quality at Pipe Springs, Zion, Bryce Canyon, and Grand Canyon, and about effects on water quality at Pipe Springs.

* * *

The investigator for a project monitoring sound levels at Rainbow Bridge, Glen Canyon, and Dinosaur, reported that sound levels at these parks were comparable to that of a "very quiet concert hall" during most periods, and were routinely at the lower limit of detection of the monitoring equipment (10 to 20 dBA). This, along with other sound monitoring efforts in the region, indicate that the Colorado Plateau is one of the "quietest" places left in the country.

Similar results have been documented for air quality in this corridor. Primary sources of "unnatural noise" at the sites monitored were visitors and motorboats. Main sources of "natural noise" were wind, insects, and birds.

* * *

In compliance with a Congressional mandate, a draft Impact Analysis and Risk Assessment report concerning the Corwin Springs Known Geothermal Resource Area (KGRA) has been completed. Potential exists for private geothermal development in the Corwin Springs area, which may impact Yellowstone's geothermal features.

regional highlights

Research conducted to determine if there are cross-boundary connections between Yellowstone geothermal resources and those in the Corwin Springs area found *no* evidence of any such geologic barrier, and that there *is* evidence of geothermal fluid movement between the two areas. The report recommends alternatives for Congressional consideration to avoid impacts to Yellowstone's geothermal resources. Final report will be submitted to Congress by April 15, 1991.

* * *

The Colorado Mine Land Reclamation Division recently used a relatively new technique to close the Kodel Mine at Colorado National Monument. The project was funded through a cooperative agreement between NPS and the State of Colorado. Two "winzes," vertical opening dropping off the main level, were bulkheaded using a polyurethane foam (PUF). This was the first time a closure was attempted using PUF mixed by hand in winter ambient air conditions. The project was successful. The foam sealed the openings thoroughly and its density, although not optimum, was in the good range. The project was done by backpacking all equipment, chemicals, and other supplies approximately one mile to the mine. Its significance lies in demonstrating the practicality of using backpack techniques to close hazardous mine openings.

* * *

Glen Canyon NRA recently hosted the annual Colorado Plateau Workshop, held late in January at the Wahweap Lodge near Page, AZ. Over 50 resource managers, superintendents, scientists, rangers, interpreters, planners, and public information staff from the Rocky Mountain, Southwest, and Western Regions attended, together with representatives of CPSUs, contractors, and private organizations such as the Grand Canyon Trust.

The conference included updates on park research, reptile and small mammal populations studies, and NRPP projects concerning peregrine falcons, desert bighorn, insular populations, and Quaternary studies. CPSU activities at both U/WY and Northern AZ/U were presented. Briefings were provided on the 1989 Clean Air amendment, the Navajo Generating Station, the status of EISs for Glen Canyon Dam and Western Area Power Administration, and the reclamation of abandoned mineral lands. Collections management and ethnographic responsibilities were discussed and an overview of the Native American Graves Protection and Repatriation Act was presented.

* * *

The Federal Noxious Weed Act of 1974 (7 USC 2801 et seq) has been amended by Sec. 1453 of the Food, Agriculture, Conservation, and Trade Act of 1990 (Public Law 101-624). Among other things, the act states that Federal agencies "shall enter into cooperative agreements with State agencies to coordinate the management of undesirable plant species on Federal lands." "Undesirable plants" cannot include endangered species or plants indigenous to the area where control measures are to be taken.

* * *

Zion NP resource management rangers, with collateral law enforcement and paraprofessional archeology duties, assisted Big Hole National Battlefield (BIHO) in the retrieval of a priceless artifact stolen from the BIHO Visitor Center in 1972. The artifact is the peace pipe that belonged to Chief Joseph of the Nez Perce – one of the tribe's greatest leaders. BIHO initiated the case in September 1990, with the development of local informants, who revealed that the artifact presently was in St. George, UT, near Zion. Zion resource rangers investigated, in conjunction with the FBI, and recovered the peace pipe from the suspect in December. Criminal and civil charges currently are pending, and the pipe has been returned to BIHO.

* * *

Yellowstone NP's report to Congress on the grazing question for the northern elk winter range will be completed by July 16, 1991. Comprising approximately 25 sections in 3 volumes, the report will summarize work conducted between 1986 and 1990. For more information on the report, contact John Varley, Chief of Research, Box 168, Yellowstone NP, WY 82190.

* * *

Glacier NP has been selected as one of several NPS areas where studies will be funded for global climate change research. The Glacier Biogeographic Area provides ideal conditions for testing climate change hypotheses. The geographic location, topographic features, and prominent ecotones allow the study of ecological processes that influence composition, distribution, and sensitivies of biotic communities. If the planet is warming, all living things will be affected, but neither the capacity for rapid adaptation nor tolerance levels for change is known. It is hoped that through the studies at Glacier, models can be developed that will predict more general effects. A new position, Global Climate Change Coordinator, and support funds, have been granted and specific research proposals are being developed.

* * *

Natural Resource personnel from the Region's Great Plains parks, the U/WY CPSU, and the USFS Experimental Station in Rapid City met at Wind Cave NP February 26-27 for a first annual Great Plains Resource Management Workshop. Included were updates on park research, bighorn sheep, the regional GIS plan, the Global Warming proposal for Prairie Parks, IPM (Canadian thistle, Japanese brome, and other alien species), prairie restoration, insular population studies, resource management plans, NRPP funding, and the on-going I&M program. Representatives of the USGS Experimental Station and the Wyoming CPSU discussed their programs; Boise Interagency Fire Center Prescribed Fire Specialists discussed fire management issues.

* * *

The Region's GIS plan, nearing completion, is being reviewed in the Regional Office and WASO GIS Division. It will be available for park review by April.

The plan sets forth as its first priority the need to concentrate on database construction. It also identifies parks that are logical candidates to develop individual capability as well as parks that will be designated as "node" parks for clusters of parks. These node parks will develop a GIS database construction and analysis capability for themselves and the other parks in their cluster. Whereas larger parks will want to purchase UNIX workstations, the expectation is that smaller parks that are part of the clusters eventually will be able to purchase smaller systems that meet their data processing needs and at the same time will be user friendly. These systems are expected to be functional in 3 to 5 years or less.

* * *

The Rocky Mountain Wolf Restoration Committee, authorized by Congress in the FY91 Appropriations Bill, has begun putting together a plan for restoration of the species in the Central Idaho wilderness and the Greater Yellowstone Ecosystem. The 10-member committee is composed of the state game and fish directors from Montana, Wyoming, and Idaho and representatives from USFS, NPS, USFWS, the Wyoming livestock industry, the sport hunting industry, and the Defenders of Wildlife. Meetings have been held in Denver and Cheyenne; others will follow in Helena and Boise. Public workshops are being held in conjunction with the committee work sessions. Additional work in April will complete the plan due to the Secretary of the Interior by May 1 for review and transmittal to the Hill.

Zandy Hillis, Resource Management Specialist at Buck Island Reef National Monument (BUIS), is looking for radio telemetry equipment to use on a hawksbill turtle tracking project. If anyone has receivers, antennas, headsets or other tracking equipment they would be willing to loan or transfer to BUIS, please contact Zandy at 809 773-1460.

Southeast Region

USFWS Regional Director James Pulliam Jr. signed a Finding of No Significant Impact (FONSI) based on a final environmental assessment of the Florida panther captive breeding program. This clears the way for the USFWS to issue permits which will allow panthers to be captured and held for captive breeding purposes. Permit issuance was anticipated 30 days after the December 19 publication of the FONSI in the ***Federal Register***. However, the process was delayed when the Fund for Animals filed suit to suspend permit issuance until completion of a full environmental impact statement. A meeting of the Technical Subcommittee of the Florida Panther Interagency Committee was held in mid-January to plan implementation of the first phases of the captive breeding program.

* * *

The first annual Mammoth Cave Karst Research Conference was held on December 17 and 18 at Mammoth Cave NP. Sixteen people, including Joe Meiman and Martin Ryan of the MACA staff, presented papers on various subjects relating to Karst hydrology. At the close, the group recommended topics and format for future conferences.

* * *

The endangered red wolf has returned to the Great Smokies after being extirpated from the area nearly a century ago. In a joint NPS/USFWS project, two pairs of red wolves have been brought to the Cades Cove area of Great Smoky Mountains NP and placed in an acclimation compound. They were expected to breed in February and have pups in April or May. In August one wolf family will be fitted with radio transmitters and released; the second family will be held in reserve. NPS Director James Ridenour, Supt. Randall Pope and USFWS officials were present when the wolves arrived, and held a formal press conference to announce the event. Wildlife artist Steve Jackson presented Director Ridenour with the first print of his new red wolf painting, and donated the proceeds from the first 500 prints to the recovery project.

Global Change Program Update

By David Figlio

The Global Change Program Committee (GCPC) met in Reno, NV, the week of January 28 to review Global Change Capabilities and Interest Statements from 14 biogeographic areas. The GCPC identified 10 of these as being significant to a national global change research program.

Of these 10 areas, Big Thicket, Central Grasslands, Channel Islands, Hawaiian Islands, South Florida, and Upper Rio Grande Basin, were regarded as particularly important additions to the existing NPS global change network; these will be invited to submit Global Change Operations and Conceptual Research Plans (GCP), according to target schedules in official Washington Office (WASO) memoranda.

These schedules are being developed so that lower ranked biogeographic areas won't be putting out a lot of effort chasing the limited dollars in the program at this time. In order to provide preparers additional time, this next round of GCPs will be due to WASO by Sept. 3, 1991, rather than in May as previously indicated. The other 4 areas – Central California Coast, Chihuahuan Desert, Colorado Plateau, and Greater Yellowstone – will be invited to submit GCPs as additional funding becomes available.

At the request of biogeographic area coordinators currently preparing full research proposals, the Associate Director, Natural Resources, provided guidance on selection of technical peer reviewers. Full research proposals were due at be WASO by March 15 and the due date for peer reviews was March 29. The GCPC met in Boulder, CO, the week of April 8 to review these proposals.

All of this is being written in February, so if any questions arise between my writing and your reading, they can be answered by Pete Comanor at 202-343-8126.

Figlio is a staff member of the NPS Wildlife and Vegetation Division, WASO.

letters

Hi Jean: Thanks so much for starting up my subscription to ***Park Science*** again. It wasn't until I read the recent issue that I realized how much I have been missing.

I have started four volumes on ***Birds of the U.S. National Parks*** and the first volume on the East Coast parks is slated to be out in early 1993. I hope to produce a manuscript yearly, and the next three will be the Rocky Mountain states, West Coast, and Central states. The up-to-date issues of ***Park Science*** contain good stuff which I can use in these books.

The audience is the average person going to the parks who notices wildlife and would be interested in learning more about the park's birdlife. The idea is to hook that person on a common bird and entice him/her into the next step of getting interested in other park birds and habitats. Research, resource management, and interpretive activities will all be included. You can understand the value of ***Park Science*** to me.

Ro Wauer
202 Padre Lane
Victoria, TX 77901

meetings of interest

1991

May 14-19, INTERNATIONAL CONFERENCE ON SCIENCE AND THE MANAGEMENT OF PROTECTED AREAS, at Acadia University, Wolfville, N.S. Canada. To serve as a forum for examining current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research, and as a lead-up to the IUCN World Parks Conference, 1992. Contact Neil Munro, Director, Policy Planning & Research, Canadian Parks Service, Atlantic Region, Environment Canada, Historic Properties, Halifax, Nova Scotia, Canada, B3J1S9.

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

May 29-31, 12TH ANNUAL MEETING OF THE SOCIETY OF WETLAND SCIENTISTS, at Ann Arbor, MI, covering wetlands research and management from many different disciplinary approaches. Contact: Douglas A. Wilcox, USFWS, National Fisheries Research Center-Great Lakes, 1451 Green Rd., Ann Arbor, MI 48105; 303/994-3331.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact, Vice President, Programs Service and Information, National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, DC 20036.

October (no date given in ititial announcement), SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme, "Wildland/Urban Interface," at Lake Tahoe, interfacing resource managers and scientists in small group discussions of research findings. Sponsored by USFS, BLM, Society of American Foresters and others. For information write Debbie Chavez, SARR Symposium Coordinator, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

Nov. 3-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL – JOINING HANDS FOR QUALITY TOURISM, to be held in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Registration and travel/housing information available in April. Contact: Ray Tabata, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA; (808) 956-2866; FAX (808) 956-2858.

1992

May 17-20, FOURTH NORTH AMERICAN SYMPOSIUM ON SOCIETY AND RESOURCE MANAGEMENT, in Madison, WI. Contact: Donald R. Field, 1450 Linden Dr., Madison, WI 53706.

Arbor Day Foundation Sets Training Institute Dates

From Dr. James R. Fazio, former department head of Resource Recreation and Tourism at U/ID and now on loan to the National Arbor Day Foundation, comes word of establishment of the Foundation's new Institute, created to serve as a training, continuing education and professional development arm of the Foundation. Designed to help close the gap between what is known about trees and what is practiced, the following 1991 event schedule has been established, with Fazio as contact.

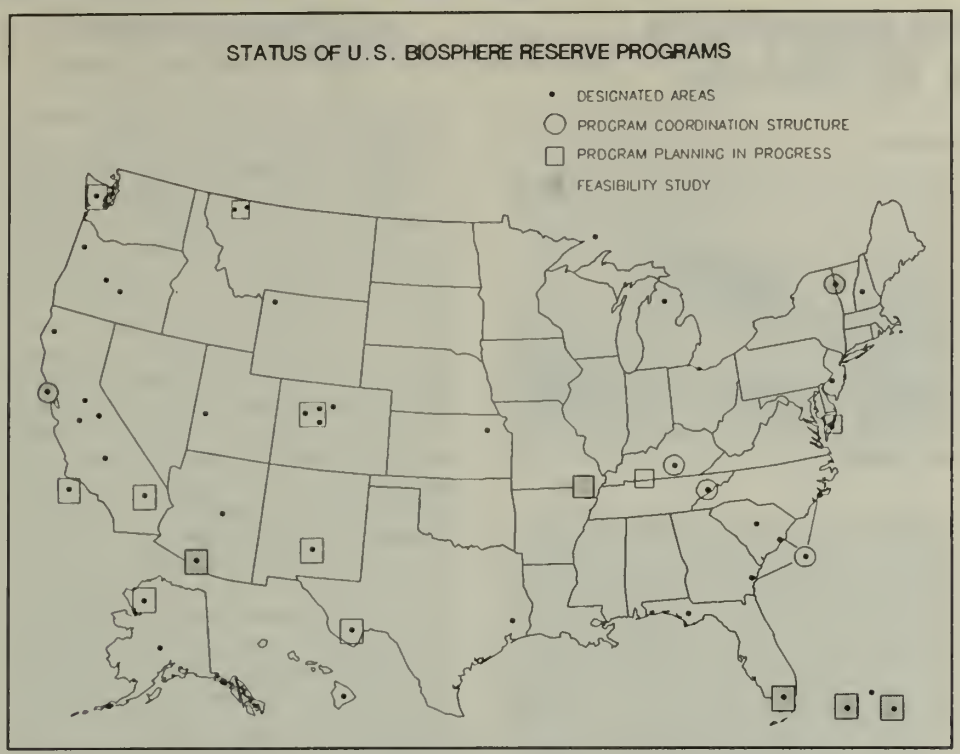
May 2-3, MODERN ARBORCULTURE – A SYSTEMS APPROACH TO PRACTICAL TREE CARE, by Dr. Alex Shigo, at Nebraska City, NE.

May 7-8 and 9-10, TREE INVENTORY WORKSHOP and COMPUTER SOFTWARE FOR STREET/PARK TREE INVENTORY AND MANAGEMENT, by ACTR, Inc., Kent, OH, with the Arbor Day Institute. Workshops may be taken together or separately, and are repeated Oct. 15-18.

Sept. 8-12, SKOG TUREN – THE TREES AND FORESTS OF SCANDINAVIA, a travel course that includes a look at environmental problems and research in Iceland, Norway, and Sweden.

Nov. 22-23, NATIONAL FUELWOOD CONFERENCE, with focus on technology available for using wood as an alternative to non-renewable energy sources, Lincoln, NE.

For more information or a complete course catalog, contact Dr. Fazio at The Arbor Day Institute, PO Box 81415, Lincoln, NE 68501; (402) 474-5655.



The map above summarizes the status of U.S. Biosphere Reserve programs. BRs with a program coordination structure include the Southern Appalachians (established MAB cooperative) and the Carolinian-South Atlantic, Central California Coast, Champlain Basin-Adirondack Mountains, and Mammoth Cave Area (all with informal structures including a coordinator and/or program committee). Program planning is underway at Catskill Mountains, Channel Islands, Chihuahuan Desert, Colorado Rockies, Glacier NP Area, Land Between the Lakes Area, Mojave and Colorado Deserts, and Northwest Alaska. Feasibility studies for regional BR programs are underway at Central California Coast, Champlain Basin-Adirondack Mountains, Guanica Area (Puerto Rico), Ozark Highlands, South Florida, Sonoran Desert, and Virgin Islands. Most of these study reports are due in 1991. Not all the areas above include designated BRs.

publications

Another handsome new addition to the ranks of environmentally-oriented publications is ***Earth Work***, product of The Student Conservation Association, Inc., with editorial headquarters at 1800 N. Kent St., Suite 913, Arlington, VA 22209 (703) 524-2441.

The monthly describes itself as being for you who "don't just want a job, you want a career protecting the Earth." The introductory issue came to ***Park Science*** from Destry Jarvis, executive vice-president of the SCA. ***Earth Work***'s special feature, "Job Scan," provides the most comprehensive listing of natural resource and environmental job opportunities anywhere, and its articles focus on the people, the agencies, and the nonprofit organizations that protect parks, refuges, forests, and other such lands.

Subscriptions are $29.95 for 12 issues; single issues, $6.00. More information about SCA charter membership savings may be had from the Student Conservation Assoc., Inc., PO Box 550, Charlestown, NH 03603-0550.

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Natural Science, Conservation Biology Books, Catalogue 38, 1991, is now out, from Patricia Ledlie Bookseller, Inc., One Bean Rd., PO Box 90, Buckfield, ME 04220; (207) 336-2778. The company issues five catalogues a year and features different subject areas in each one. The initial 1991 catalogue contains 586 titles, covering birds. botany (including cryptogams), and miscellany (including mammals, insects and other invertebrates, reptiles, amphibians, and fishes).

• • •

The Wetland Training Institute, Inc., of Poolesville, MD 20837-0099, (PO Box 1022), has issued a 12-page publication entitled ***Wetland & Water Resource Training***, announcing its 1991 course schedule and featuring 53 sessions of 19 different courses – 11 of them new (not offered in 1990).

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A new set of guidelines to help manage State-owned and federally-owned shipwrecks has been issued by the NPS. The final version, entitled ***Abandoned Shipwreck Act Guidelines***, was published in the ***Federal Register*** on Dec. 4, 1990. Copies are available free, from the Department Consulting Archeologist, NPS, US Dept. of the Interior, PO Box 37127, Washington, DC 20013-7127.

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A brochure announces formation of an ambitious new foundation – the Denali Foundation of Alaska: "to benefit our planet, the state of Alaska, and Denali National Park through research, education, and communication."

Michael Cobbold, executive director, with headquarters at P.O. Box 212, Denali Park, AK 99755, disclosed plans for a 1991 Science Conference (no dates given) "to bring together a wide range of experts to develop scientific consensus for research at Denali NP that meets the needs of park management, provides greater understanding of global environmental change, and that can serve as a model for other equivalent preserves."

Donated land adjoining Denali NP will be used by the Foundation for a research center.

The Foundation is being established with part of the royalties from the sale of ***Grizzly Cub***, written by Rick McIntyre and published by Alaska Northwest Books.

mab notes

Bill Gregg, NPS MAB Coordinator, sees growing support for the biosphere reserve/MAB regional program idea.

"There is more activity now than ever before," he says. "But the push is coming as much from outside groups as from government agencies. For instance, the Grand Canyon Trust is exploring a regional program for the Colorado Plateau; Friends of ProNatura for the Sonoran Desert, and informal private interests for the Sierra Nevada and Upper Rio Grande Valley. For the sake of pursuing worthwhile regional and international goals, our biggest need now is a more structured program and more guidance for participation in BR programs. Those should be well spelled out when the Action Plan for Biosphere Reserves and operational guidelines are completed.

Napier Shelton
NPS Washington Office

Revegetation Efforts Using Native Species

A number of Rocky Mountain Region parks are using native vegetation to rehabilitate Federal Lands Highways Program (FLHP) road corridor disturbance. Extensive programs are beginning or continuing at Grand Teton, Bryce Canyon, Mesa Verde, Yellowstone, and Glacier. Each of these parks has selected native species believed to be environmentally appropriate and genetically acceptable for its particular rehab needs.

Native seed or cuttings are collected from the parks to be propagated at a Soil Conservation Service (SCS) plant materials center. Here, native grass seed is propagated over several seasons to produce large quantities of seed which, in turn, is returned to the park. SCS also will propagate shrubs from cuttings or seeds to be returned to parks for planting at the appropriate time. FLHP funds have paid for the SCS plant propagation for these 5 parks.

NPS revegetation/restoration expertise is available from the NPS Plant Materials program, staffed by Rocky Beavers and Wendell Hassel, and located in Professional Support at the Denver Service Center. Both these individuals are available to advise parks which species to use for reveg efforts and how to develop them through the SCS plant material centers. Sarah Wynn is Vegetation Restoration Coordinator for the Rocky Mountain Region.

In order to develop as much information as possible about how to revegetate disturbed areas using native vegetation, the Branch of Science asks those parks involved in such efforts to monitor all ongoing projects and if possible to establish a research plan.

Society and Resource Management

The Fourth North American Symposium on Society and Resource Management has been scheduled for Madison, WI, on May 17-20, 1992. The Symposium will focus on the integration of social and biological sciences as they address, together, natural resource and environmental issues.

For further information, contact Donald R. Field, Program Chair; School of Natural Resources; 1450 Linden Drive, Madison, WI 53706.

Search for Cave Swallow's Winter Range Underway

By Larry W. Johnson

Carlsbad Caverns, long known for its tremendous rooms and incredible formations, also houses the last bird species on the North American continent for which the winter range is unknown. The Cave Swallow, a close relative of the Cliff Swallow, makes its summer home nesting just inside the entrance to Carlsbad Cavern. Scientists at Carlsbad Caverns NP currently are engaged in one of the region's largest ornithological banding projects in an effort to learn more about this bird and ultimately to discover its winter range.

The Cave Swallow is a regular summer resident of Mexico, the West Indies, and northern South America, and currently is expanding its range northward and eastward into the United States. A relative newcomer to Carlsbad Caverns, the birds were first sighted in the cave in 1966, when two or three pairs arrived and built their nests just inside the cave entrance. Prior to 1966, the birds were known to roost only in a few very isolated locations in remote canyons nearby. Since then, the colony inside Carlsbad Cavern has increased to upwards of 4000 birds – the largest and northernmost active colony known to exist.

Cave Swallows (*Petrochelidon fulva*) are easily distinguished from the more familiar Cliff Swallows by their buff-colored throat and their practice of building a small, half-cup nest of mud, grass, and feathers instead of the fully enclosed, gourd-shaped nest of the Cliff Swallow. The primary nesting sites chosen by the birds are caves, although the birds have been seen occupying adobe buildings, silos, and similar structures.

Carlsbad Caverns is one of the few locations in the United States where the species can be seen readily by the general public, so park visitors get an extra treat when they come to see the caves. The swallows are interesting and fun to watch as they chatter, swoop, and make spectacular dives and maneuvers into and around the cave mouth.

Like the famous bats of Carlsbad Caverns, the Cave Swallows are predictable migrators. They usually arrive at Carlsbad in February and depart for unknown wintering grounds by November. Soon after arrival of the first nesting pairs in 1966, a massive banding and study project was undertaken in an effort to learn more about the birds. Steve West, a local school teacher and NPS volunteer, heads the project. Project volunteers include park rangers and students from West's school, who get hands-on experience in netting, handling, measuring, and weighing the swallows.



Cave Swallow

Thousands of birds have been banded in the hope that some day a band will be recovered and returned to give a clue to the species' winter range. So far, no bands have been recovered outside Carlsbad Caverns, but the research indicates that the same birds do indeed return yearly to nest in the cave. There has been one reported sighting of a Cave Swallow in northern South America (Aruba) during the winter months, but whether that bird was part of the Carlsbad colony was not determined. One of the project's most unusual findings so far was the discovery of an albino Cave Swallow nesting in the cave.

While two or three bird species in North America may have questionable winter ranges, ornithologists generally agree that the Cave Swallow is the last and only species for which the winter range is virtually unknown.

Johnson is a Park Ranger at Carlsbad Caverns NP.

revegetation notes

Brooklyn Native Seed Bank Project Near Completion

In June 1989, a joint effort at abandoned minelands reclamation was launched between the USFS Research Station in Princeton, WV, and New River Gorge NR. The project, known as the Brooklyn Reclamation Project, involved using layers of topsoil and leaf litter as a source of seed – a method known as native seed banking, and moving it to disturbed unvegetated sites.

The project site consisted of a 40+ year old half-acre coal refuse pile that was subject to washouts and gullying and completely bare of vegetation. The 20' x 20' plots were installed in June, October, April, and the following June, and were replicated 3 times. The plots were treated with lime and fertilizer, and the seed bank source area was selected based on the quality of topsoil, density of leaf litter, and presence of desirable native species.

By installing the plots during different times of the year, we hoped to determine whether there would be a significant difference in the emergence of native vs. alien species and which time frame resulted in the quickest growth. The resource management staff is currently collecting final data and a formal research report, co-authored by the NPS and USFS, will be published this summer (1991).

It is hoped that the results will provide us with a low cost method of disturbed site revegetation that encourages the emergence of native species. Anyone interested in the project can obtain more information from Carol A. Pollio, Natural Resource Specialist, New River Gorge NR, at (304) 465-0508.

NPS Projects Underway At U/WY Research Center

Three projects of some general interest now underway at the NPS U/WY Research Center are:

(1) Changes in Geomorphic Processes in the Snake River Following Impoundment of Jackson Lake. (Richard A. Marston). Findings from the second year of a 3-year project in Grand Teton NP are helping identify potential conflicts over management strategies for the Snake River. An inverse relationship has been discovered between geomorphic stability (channel bar migration, lateral shifting of channels, aggradation/degradation) of the Snake River, and the diversity (relative richness) of floodplain communities.

Commercial river runners would prefer a stable, single-thread, meandering channel for improved navigation and safety. This contrasts with the desires of wildlife biologists, who would prefer a multiple-thread (braided or compound), unstable channel, which condition is associated with maximum diversity of floodplain vegetation. Channel stability and vegetation diversity, in turn, have been affected by the operation of Jackson Lake Dam. Lower peak flows and higher late summer flows in the Snake River since 1957, when the Jackson Dam release schedule was changed, have accelerated succession by eliminating destructive early summer flows and by elevating the late summer water table.

Work in the third year of the project will involve compilation of a sediment budget for the Snake River watershed, using GIS technology to develop a predictive model of river channel response.

(2) An Evaluation of Earthquake Hazards of the Grand Teton Fault. (Robert B. Smith, John O. Byrd, David D. Susong, Arthur G. Sylvester, Ronald L. Bruhn, and John W. Geissman). The Teton fault is a major, range-front normal fault that bounds the east side of the Teton Range, located in northwestern Wyoming. This fault is the primary structure responsible for producing more than 2100 meters of vertical topographic relief and is the single most important factor contributing to the spectacular topography and scenery of Grand Teton NP.

Dr. Smith and his team are conducting a multi-year investigation of the Quaternary faulting of the Teton Fault, including timing of faulting, earthquake induced ground deformation, and paleomagnetic measurements of fault deformation. On the basis of the long term record, Dr. Smith's team believes that future earthquakes of magnitude $6.3<Ms<7.5$ are expected to continue in the Hebgen Lake-Yellowstone-Teton region, with expected recurrence intervals on the order of once every 1000 years.

(3) Feral Horse Distribution, Habitat Use, and Population Dynamics in Theodore Roosevelt NP. (Clayton B. Marlow, Leonard C. Gagnon, Elena Hovland, and Lynn R. Irby.) Description of the ecological niche filled by feral horses in Theodore Roosevelt NP requires information on reproductive rates, home range size, individual and band affinity to home ranges, food and shelter requirements, and seasonal diets. The information will be used to integrate horse requirements with those of elk, bison, and vegetation to determine the ungulate carrying capacity.

To date, Dr. Marlow's research team believes that long term stability of individual bands and high fidelity to certain areas suggests the likelihood of overgrazing, especially when the concurrent patterns of elk and bison are included. Based on preliminary results, they believe that horse management might have to be more intensive than that for elk or bison.

A Commentary on Visitor Statistics

Editor's Note: It takes all kinds of people to make up a world, and some of them seem to be 2 or 3 different individuals wrapped into one outer covering. Crusty, cantankerous, gun-toting poets aren't your run-of-the-mill park visitor (or your usual hunter, either). But listen to one of them, and it could surprise you into reexamining some of your own comfortable ruts.

By Al Lovaas

Recently, Dick Briceland announced visitation figures for September 1990. There were 25,775,338 recreation visits to the National Park System that month, of which Alaska Region had 148,909, or a little more than half of 1 percent, while 56 urban parks alone scored 7,050,180. For the year to date, Alaska recorded 1,089,906 of the total 210,397,573. While these are important statistics, obviously they are not intended to, nor do they, tell the whole story about visitor use of NPS areas.

Toward the end of that very month I made one of my infrequent recreational visits to an NPS area. There, 130 miles north of Nome, I reveled in the silence, the loneliness, the empty, roadless, sweepingly-open vistas of a truly wild place. I exulted in being alive; in the interplay and flex of my muscles; in the pleasant exertion of hiking hillsides where mosses, lichens and forbs displayed pastel autumnal abstractions reminiscent of a Jackson Pollock paint-dribbled canvas (although I doubt the artist ever saw nature's originals).

I marveled at the soaring, flashing speed of a gyrfalcon; a near straight-line trek to nowhere by a ponderous lone musk-ox; large flocks of ptarmigan wheeling in flight, their whiteness stark against sienna tundra and willow. I was enraptured by the mysterious, undulating, glowing beauty of northern lights in the clear night sky. I was struck by the purity and silence of freshly falling snow, creating its mood of timelessness and antiquity. I was lulled by the musical murmuring of clean water flowing endlessly over ancient stones in a tiny brook.

I shot and killed a fine bull moose. I made a longish shot, but one well within the range of my .300 Win. magnum and he fell in his tracks to a 200-grain handloaded bullet, although I had to stick a finisher in his ear. He was sleek and fat and beautiful; I may have been the only human he ever saw. I venture to say not any of the 7,050,180 legitimate recreation visits to 56 urban park area in September, nor the 1,065,333 to Yellowstone, Olympic, and Zion that month resulted in the deliberate killing of a large wild animal.

I gutted and quartered my moose and with help from three companions packed the meat to the tiny airstrip and loaded it into a small plane to begin the journey to my home in Eagle River, Alaska. I did not depart, myself, for several days because of inclement flying weather and the need to assist companions in getting out two more moose. While we saw tracks, we did not get a chance to kill any grizzly bears.

The delicious, low in cholesteral, unadulterated, tender, and very expensive meat was stored respectfully and carefully in my freezer alongside packaged fillets from 23 sockeyes I dip-netted in June from a river forming part of the boundary of another NPS area. Injuries from orcas, seals and commercial fishermen's nets on a few of those bright, handsome fish were reminders of the incalculable odds they faced during a lifetime of peril, and of their dauntless determination to surmount any obstacles in returning to their natal streams to reproduce their kind. My dip net finally snuffed out that determination so close to their final goal, with only a few fish wheels and predators left between them and their spawning streams. I do not waste their succulent flesh.

I made my September recreational visit to a 2,785,000-acre national preserve, which by law is administered exactly as a national park except that sport and subsistence hunting and trapping are permitted and, in that particular preserve only, reindeer herding. The salmon were taken from a 13,188,000 acre park and preserve. In the early 1980s, I killed three caribou on the preserve, but not qualifying as a local rural resident, I could not participate in subsistence hunting in the park. My hunts were accessed by small planes on marginally short, narrow, rocky, and in one instance tree-girt, landing strips that barely qualified for that designation. On one flight, I saw a gorgeous, rollicking grizzly bear, but never was fortunate enough to find one while hunting.

Consumptive uses present problems, but they also present opportunities foreclosed by complete protection: "The National Park Service recognizes and the Committee agrees, that subsistence uses by local rural residents have been, and are now, a natural part of the ecosystem serving as a primary consumer in the food chain" (Legislative History, Alaska National Interest Lands Conservation Act). We are mandated also "to insure that consumptive uses of fish and wildlife populations within NPS units not be allowed to adversely disrupt that natural balance which has been maintained for thousands of years" (ibid.).

But how much consumptive use is natural and not adversely disruptive? Research, inventory and monitoring can provide guidance; comparisons with research results from totally protected parks are essential. And how much effect, if any, on the biological processes are we mandated to continue unimpaired by adverse human activity is coming from arctic haze, global climate change, reindeer herding, fire protection/management, special Alaska provisions for ready visitor access and transportation, missing or unnaturally reduced life forms, development of world-class mines near parks, changes in life styles by indigenous people, desires of suburbanites like me to become natural parts of ecosystems, and increasing human populations?

Are the answers to these questions really important? I believe they are essential, not just to manage national parks and preserves in Alaska, but to help at least a little in guiding humankind into an uncertain future. How can we tell what direction we are going if we don't know where we began?

Whether visitors are merely looking at something of interest in an NPS area or whether they are shooting, trapping, or netting something must obviously be considered in management formulas along with the numbers of recreation visits.

Visitor expectations are important. If cost is dependent largely upon comparative scarcity, Dr. Briceland's figures indicate recreation visits to the Alaska Region approach pricelessness. Many of the visits are once-in-a-lifetime experiences; all are expensive and time-consuming. Discriminating buyers expect top value when they pay top dollar and they deserve to get it. While the word "great" has become hackneyed, Alaska deserves its title, "The Great Land." To meet great expectations of visitors while preserving great but often fragile resources and wilderness ambiences requires sophisticated management and decision making dependent upon expensive information. Chip Dennerlien, in a 1988 ***George Wright Forum*** (Vol. 5, No. 4) paper eloquently and succinctly described the challenges of managing northern and remote parks.

A national park manager from the simpler, less crowded, less knowledgeable world of not all that long ago would be amazed if he could look in on the Alaska Regional Office of today. There are divisions of Protection and Ranger Activities,. Budget and Finance, Planning, Concessions, Personnel, Environmental Compliance, Facility Design and Maintenance, Contracting and Property, Cultural Resources, Interpretation and Visitor Services, Subsistence, Land Resources, Information Management, Minerals Management, Natural Resources, and an Office of Oil Spill Coordination.

All are essential or they wouldn't exist in these times of tight budgets, and all are bustling to try to turn concepts into reality in this modern world. I'm sure though that the old timer had plenty of problems to contend with, and probably if anything a more negative ratio of resources to needs. Nobody ever said it was, is, or will be easy, but for sure it will get even more complicated, which must be recognized by the American people if we are to continue to receive their support.

Lovaas is Chief Scientist in the NPS Alaska Region.

Colonial Mowing Pattern Changes Paying Off

The changes in mowing patterns at Colonial NHP described by Chuck Rafkin on page 16 of the Fall 1990 issue of ***Park Science*** already are paying off in 2 park fields. Word from Rafkin is that natural vegetation, including wildflowers, are suppressing the johnson grass in these fields.

"With this in mind," he writes, "we have developed and initiated a plan with the local Colonial Water and Conservation District to conduct a cooperative experimental demonstration project to suppress johnson grass in the park, employing selective vegetative management techniques without the use of herbicides."

The Colonial Soil and Water Conservation District is providing technical assistance, financing, and the use of a no-till seeder to the park. Additional technical support is being provided by Jeff Marion, Mid-Atlantic Regional research scientist.

The park is benefitting from the work of graduate students in the course entitled Federal Jurisdictional Wetlands Delineation at the Virginia Institute of Marine Sciences, College of William and Mary. Their class project is to survey for non-tidal wetlands the open fields of the park's Yorktown Battlefield unit. Areas meeting the Federal guidelines have been delineated and mapped. The park will be supplied with the maps and reports on each area and the information will be added to the park GIS.

With regard to the water resource management plan for the park, a change of cooperators now has the park working with the William and Mary Virginia Institute of Marine Science under a cooperative agreement. Dr. Carl Herschner, head of the Wetland Ecology department, and Dr. Suzette Kimball, geologist in the Division of Geological and Benthic Oceanography and co-director of the Virginia Coastal Inventory program, are the principal investigators.

Chiricahua Mountains Annotated Bird Checklist

By Kathy L. Hiett, R. Roy Johnson, and Michael R. Kunzmann

Southeastern Arizona may be the premiere inland bird watching locality for the United States, and is considered by many ornithologists and birders to be excelled by few other places in the world, but only in recent years has the popularity of the area become apparent. Portal, a small community on the eastern fringe of the range caters to birding groups and dispenses information on local attractions. The U.S. Forest Service provides local information, maps and a checklist (1989) of birds in the Chiricahuas and operates recreational facilities throughout the range that are heavily used by birdwatchers from around the world.

Many come seeking to add to life lists and search for specialty birds from this region, with the most sought after birds being those from the Sierra Madre Occidental of northern Mexico. Examples of Madrean birds that regularly summer and breed in the Chiricahuas include: the Elegant Trogon (*Trogon elegans*), Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*), Red-faced Warbler (*Cardellina rubrifrons*), and Painted Redstart (*Myioborus pictus*), to name a few of the more colorful species. Numerous other "Mexican species" are permanent residents, reaching their northernmost limits in the extreme southwestern United States. These include the Strickland's Woodpecker (*Picoides stricklandi*), Gray-breasted (Mexican) Jay (*Aphelocoma ultramarina*), and Mexican Chickadee (*Parus sclateri*).

For the past three years, scientists at the Cooperative Park Studies Unit at the University of Arizona (CPSU/UA) have conducted an inventory of the Chiricahuas. The method for collecting information and determining species annotated accounts was designed by R. Roy Johnson. Computerized information management and compilation of observation and breeding data were coordinated by Michael R. Kunzmann. The related project for the vegetation and habitat classification system was contributed by Peter S. Bennett.

Since the establishment of the American Museum of Natural History's Southwestern Research Station (SWRS) near Portal in 1955, researchers have come in increasing numbers to explore the biological riches of the Chiricahuas. This research has greatly expanded the knowledge of the mountain's flora and fauna and resulted in the compilation and publication of field checklists for Chiricahua NM as well as for the rest of the range. Previous to the work of the CPSU/UA, however, no annotated checklist has been available for this area. The CPSU/UA project gathered records from the past 20 years as well as new data and provides information, verification, and references on approximately 350 avian species, found in this area.

The area studied covers the entire Chiricahua Mountain range from Ft. Bowie NHS south toward the city of Douglas, encompassing approximately 700 square miles of public land including: Chiricahua NM, Ft. Bowie, Coronado NF, and some privately owned lands. Lower elevation limits on the eastern side were set at 4,200' and for the western side at 5,000'. Data and photographs were gathered from all major habitat types (see Fig. 1) from the desert floor to montane meadows, and to Engelmann spruce forests at the summit of Chiricahua Peak (elev. 9759'). Plant community structure is illustrated with photographs.

During the avian and floristic studies conducted by CPSU/UA scientists, the mountain island diversity theory was examined as well as the biological diversity of the range. The high avian species richness, and floral and vegetative diversity is largely due to the ecotonal nature of the region. Lowland diversity is derived from the convergence of species from the Chihuahuan Desert to the southeast and plains grasslands to the northeast, with those from the Sonoran Desert to the west. Species richness for montane forest and woodland diversity derives from Rocky Mountain vegetation to the north blending with vegetation from Mexico's Sierra Madrean vegetation to the south.

Publication Components and Information Management

Prominent ornithologists and others who have studied the Chiricahua Mountains were invited to submit essays that provide the reader with a broader perspective of the cultural and natural history of the area and birds found here. Dr. Jerram Brown, SUN, the top authority on Gray-breasted Jays (formerly Mexican Jay), has authored an essay on the value of long-term observations and the stability of the jay population during his 20 year study in the Chiricahuas. Alden Hayes, a resident of Portal and author of several Chaco Culture NHP reports, described the area's cul-

Classical Checklist Categories	Breedings Birds	Brown, Lowe & Pase Categories		Merriam's Life Zones	
Forest Spruce-Fir Forest Spruce-Fir-Aspen	Mexican Chickadee Red Crossbill Golden-crowned Kinglet Steller's Jay	Madrean Subalpine Forest	121.5	Hudsonian Zone	
Pine-Fir	Olive Warbler Red-faced Warbler Flammulated Owl	Madrean Mixed Conifer	122.61	Canadian Zone	Boreal Zone
Ponderosa Pine	Grace's Warbler Hepatic Tanager Greater Pewee	Madrean Pine Series	122.62	Transition Zone	
Woodland Pine-Oak Woodland Pinyon-Juniper	Magnificent Hummingbird Strickland's Woodpecker Whiskered Screech-Owl Gray-breasted Jay	Madrean Oak-Pine Series	123.32	Upper Sonoran Zone	
Oak Woodland	Montezuma's Quail Black-throated Gray Warble Bushtit Black-chinned Sparrow	Madrean Encinal (Oak) Series	123.31		
Brush Interior Chaparral	Scrub Jay Crissal Thrasher Poor-will	Scrubland Interior Chap.	133.3		
Desert Chihuahuan Semidesert Grassland	Scaled Quail Cassin's Sparrow Chihuahuan Raven Verdin Cactus Wren	Semidesert Grassland	143.1		
Chihuahuan Desertscrub	White-winged Dove Greater Roadrunner	Chihuahuan Desertscrub	153.2	Lower Sonoran Zone	
Montane Meadows Montane Meadow	Yellow-eyed Junco American Robin Chipping Sparrow Broad-tailed Hummingbird	Madrean Sub-Alpine Grassland Madrean Montane Grassland	141.6 142.6	Hudsonian Zone Canadian Zone and Transition Zone	
Wetlands/ Riparian Areas Mixed Deciduous Canyon	Elegant Trogon Blue-throated Hummingbird Sulfur-bellied Flycatcher Painted Redstart Bridled Titmouse	Mixed Broadleaf Series Sycamore/Ash/Pine	223.2211	Higher Zones	
Mixed Deciduous Wash	Dusky-capped Flycatcher Lucy's Warbler	Mixed Broadleaf Series	223.2212		
Desert Arroyo (Wash)	Ladder-backed Woodpecker Black-chinned Hummingbird Black-tailed Gnatcatcher	Xeroriparian Series	233.23	Upper Sonoran and Lower Sonoran Zone	
Water Areas Madrean Marsh Lakes/Ponds/Stock Tanks	Black Phoebe Vermilion Flycatcher	Madrean Marshland N/A	243.5	Most Zones	
Cultural Rural Areas	Hooded Oriole Bronzed Cowbird	N/A		Lower Zones	

Figure 1. Chiricahua habitat classifications.

Scheduled for Publication Early This Year

tural and political history. Robert Morse, a local Portal retired engineer and ornithological enthusiast, suggests birding tips and etiquette.

Dr. Steve Russell, professor of ornithology at U/AZ, contributed an essay on mountain island diversity. He also was co-author of "Birds in Southeastern Arizona" with William Davis. Drs. Noel and Helen Snyder discuss the restoration efforts for the extirpated Thick-billed Parrot (*Rhynchopsitta pachyrhyncha*)in the Chiricahuas begun by the USFWS in the mid-1980s. Drs. Walter and Sally Spofford, retired Cornell Lab of Ornithology researchers and permanent residents of Portal, provided professional advice in their essay on observations, keeping good records, and on specialty birds in the area. The Spoffords and Robert Morse were especially effective in contributing critical information and observation records that have greatly assisted in producing an accurate checklist.

GIS technology has largely replaced paper and mylar maps, traditionally used to spatially locate natural resources. Computerized databases linked to GIS workstations retrieve and map resource information more efficiently than traditional methods. With an eye towards the future, a standardized database has been developed to collect locality information on all 350 plus species of birds in our study area. The program, written in Foxbase Pro, operates in an IBM/DOS 3.31 environment with at least 1.5 megabytes of hard disk storage.

By standardizing the information collected, different researchers can enter data in a consistent, defined format which is searchable by key fields, species, locality, habitat, date, and numerous other combinations. The program is linked with two related databases, one that references all 941 species of North American birds (including Hawaii) and another database referencing typical habitats found throughout the range. Future efforts will be directed toward linking UTM locality data with GIS, so species distribution maps can be produced directly.

Maps produced by Lois Kain, U/AZ, depict the study area boundary and show the Chiricahuas in relation to surrounding ranges involved in our mountain island diversity studies. The reader's understanding of the mountain's cultural history is enhanced by the adaptation of a Cochise County map from the 1890s. A schematic cross section of the range shows spatial relationships of vegetation types discussed by Peter Bennett in relation to avian distribution.

BERYLLINE HUMMINGBIRD (*Amazilia beryllina*) Erratic summer resident throughout range. Nesting: SWRS,1976 (unsuccessful, Monson & Phillips 1981); Chiricahua Nat. Mon., Natural Bndge trailhead, 18 August to 15 September 1984 was the 3rd U.S. Nesting Record and 3rd for Arizona (Amer. Birds 39:86-90, 1985). Additional sightings: Cave Creek Canyon 30 June to 1 August 1970 (H. Snyder et al.); SWRS 26 June 1981 (Pimm et. al.); Portal 9 June 1983 (P.S. Boyd); South Fork 29 June 1984 (B. Zimmer et al.); Silver Creek Spring 2 July 1984 (R. Morse); Rustler Park trail near Barfoot crossing 18 July 1984 (D. Horn); SWRS 5 August 1986 (T. Mack). Photographs, nest collected 29 September 1984.

Figure 2. Sample of species annotated account.

Species	National Geographic	Peterson Guide (1989 edition)	Golden Guide
White-throated Swift	252	246	184
Broad-tailed Hummingbird	260	218	184
White-eared Hummingbird	256	218	190
Berylline Hummingbird	254	220	N/A
Violet-crowned Hummingbird	256	220	190
Blue-throated Hummingbird	256	218	190
Magnificent Hummingbird	256	218	190
Plain-capped Starthroat	256	220	N/A
Lucifer Hummingbird	254	220	190
Black-chinned Hummingbird	258	220	188
Anna's Hummingbird	258	216	186
Costa's Hummingbird	258	220	188
Calliope Hummingbird	260	220	186
Broad-tailed Hummingbird	260	216	186
Rufous Hummingbird	260	216	188
Allen's Hummingbird	260	216	188
Elegant Trogon	232	206	192
Eared Trogon	232	206	192
Belted Kingfisher	262	206	192
Lewis' Woodpecker	266	222	198
Red-headed Woodpecker	266	222	198
Acorn Woodpecker	266	222	198
Gila Woodpecker	264	228	196
Red-naped Sapsucker	268	226	N/A
Williamson's Sapsucker	268	226	198
Ladder-backed Woodpecker	272	228	196
Downy Woodpecker	270	224	200
Hairy Woodpecker	270	224	200
Stickland's Woodpecker	272	228	200
Northern Flicker	264	226	194

Figure 3. Sample of Chiricahua Mountains cross-referenced checklist.

Species occurring in the Chiricahuas are discussed in the species account portion of the checklist (Fig. 2). Abundance and status information for preparing species accounts was determined by analyzing observation records from CPSU/UA and other field data, Chiricahua NM and Ft. Bowie NHS wildlife observation records, USFS "Birds of the Chiricahua Mountains" field checklist (1989), SWRS records, and museum specimens from various collections, especially the University of Arizona. More than 100 articles from journals and other publications provided additional avifaunal data. A list of all species recorded from the range is keyed to pages from the three most widely used field guides (Fig. 3) for the benefit of birders visiting the Chiricahuas.

Summary

The Chiricahua annotated checklist has been patterned after two annotated checklists previously produced by CPSU/UA biologists, one for Grand Canyon NP and the other for Organ Pipe Cactus NM. The coverage of this checklist has been expanded to make it more usable for both resource managers and visitors. It is scheduled to be published early in 1991 as a CPSU/UA Technical Report, after which it will be submitted to Southwest Parks and Monument Association for publication as a sale item at area visitor centers.

Hiett, Johnson, and Kunzmann are all associated with the NPS/CPSU at U/AZ, Tucson 85717.

Interagency Neotropical Migratory Bird Program

The Service is participating with the Fish and Wildlife Service, Forest Service, Bureau of Land Management, Smithsonian Institution, Agency for International Development, and Environmental Protection Agency in developing a Memorandum of Agreement for a program of research, population monitoring, information/outreach, and international cooperation. The purpose of this cooperative program will be to prevent further declines in populations of neotropical migratory birds.

The Service also is identifying representatives to a steering committee and to 8 working groups that the interagency program is establishing. In addition to coordinating efforts of the federal agencies involved, the Neotropical Migratory Bird Conservation Program will rely heavily on participation by a large number of state, international, and non-governmental organizations. Contact Mike Coffey, Wildlife Biologist, WASO, for more information (FTS/202 343-8135).

Sea-Kayakers At Apostle Islands National Lakeshore Summary of a 1989 Exploratory Study

By Carolyn C. Phelps and David W. Lime

Sea-kayaking is an emerging use that has grown dramatically over the past few years at Apostles Islands National Lakeshore (APIS) on the western shore of Lake Superior near Bayfield, WI, as well as in other parts of the country. The NPS reports that sea-kayaking use at the Lakeshore has grown from about 150 visitors in early- to mid-1980s to over 2000 in 1989.

To gather baseline information on sea-kayakers use, a study was undertaken by researchers at University of Minnesota's NPS/CPSU in conjunction with Lakeshore staff. This information will be used as background for more detailed studies in the Lakeshore and perhaps elsewhere in the Midwest Region.

Increased knowledge of sea-kayakers will help the NPS to better understand the needs of these recreationists, as well as their impact on the resource, and will facilitate the formulation of management plans and educational, interpretive, and safety programs. Data sought by researchers included characteristics of the trip and geographic travel patterns, visitor profiles, visitor satisfaction, and problems encountered by sea-kayakers.

Survey Method

Sea-kayakers were asked to register name, address, and age, on a "group information form" when contacted at either of two APIS visitor centers. Most contacts were made during issuance of the mandatory camping permit. Some contacts also were made by NPS personnel at 3 lake access points. A local sea-kayaking outfitter assisted researchers by asking patrons, both day use and campers, to complete the group information form.

While camping permits are required at the Lakeshore, day use permits are not. Because of this, day users – particularly those who did not use outfitter services, may be slightly underrepresented in the sample. However, due to the long distance of the Lakeshore from large population centers (e.g. Madison, Duluth, and Minneapolis/St. Paul), researchers do not believe the number of nonoutfitted day users is high.

All persons 16 or older who registered with us were sent mail-back questionnaires following their visits to the Lakeshore. In all, 234 surveys were mailed, most within 2 weeks of the visits. Two mail follow-ups were employed to increase participation. Of these, 203 usable surveys were returned, resulting in an 87 percent response.

Selected Survey Results

The average age of sea-kayak visitors who returned the questionnaire is 36 years, with a range from 16 to 63. Thirty percent of the visitors were from the Minneapolis/St. Paul area; an additional 12 percent were from other areas in Minnesota. Six percent were local (less than a 2-hour drive to APIS); 20 percent were from other areas in Wisconsin. Thirty-five percent were from other parts of the U.S.; 1 percent were foreign. Three-fourths of the sea-kayakers had no previous sea-kayaking experience at APIS. Of those who did, about half (47%) had sea-kayaked at the Lakeshore only once before.

The proportion of day and overnight visitors was nearly equal. Three-fourths of the visitors used an outfitter for some or all of their services/supplies. Nonoutfitted groups reported a median group size of 3. Outfitted groups show a higher median group size, but it is not reflective of actual conditions because many outfitted respondents reported the total outfitted group size rather than their own personal group size. Three-fourths of the visitors traveled with family or friends. Respondents reported hiking/exploring (53%), paddling/kayaking (34%), swimming/surfing/snorkeling (30%), and camping (28%) as primary activities engaged in.

Overall, visitor satisfaction was very high. Seventy-two percent of all respondents reported their visit as "very good," on a 5-point Likert scale ranging from "very good" to "very poor;" an additional 22 percent reported their visit as "good." Only 3 respondents (2%) rated their visit as "poor" or "very poor." Visitors also were asked to list up to 3 "high points" and "low points" of their trip – things that were most and least satisfying. Scenery/scenic beauty was reported by 36 percent as "high points," followed by visits to the sea caves (35%), absence of other people (15%), and good weather (15%). Low points listing was headed by bad weather (13%), not enough time for the visit (12%), and insects (10%). No low points were reported by 8 percent of the respondents. Low points for campers focused on problems associated with finding a campsite or with the condition of campsites (15%), insects (14%), and presence/activities of motorboaters (14%).

The mail-back questionnaire asked respondents to rate 28 potential problems on a 5-point Likert scale, ranging from "not a problem" to "a very serious prob-

Table 1. Degree of problem encountered by sea-kayakers (1989).[1]

Potential Problem	Not a Problem	A Problem		Respondents
		Slight/ Moderate	Serious/ Very Serious	
	percent	percent	percent	number
Insect bites	49	43	8[2]	187
Inadequate toilet facilities at launch site	56	35	8	190
Finding a high quality campsite[3]	52	45	3	67
Finding an unoccupied campsite[3]	59	35	6	65
Rough seas made travel difficult	66	29	5	187
Bad weather	67	30	4	192
Meeting too many other watercraft	67	30	3	192
Too few launch sites	77	20	3	190
Not enough hiking trails	77	21	2	164
Soil erosion at campsites[3]	78	21	1	79
Damage to beach vegetation caused by visitors	79	20	1	188
Litter	80	19	1	192
Finding safe drinking water	78	21	1	188
Insufficient information about things to see and do in the islands	87	10	3	188
Availability of navigational maps	88	11	2	185
People being inconsiderate	86	13	2	191
Poor quality launch sites	87	13	1	193
Someone in group received an injury	88	10	2	194
Not enough firewood	88	12	0	178
Human body waste	91	7	2	191
Too many rules and regulations	91	8	1	185
Too few rules and regulations	93	6	1	186
Loss or damage to personal property	94	5	1	194
Navigating among the islands	93	7	0	176
Overall maintenance of the area	94	6	0	189
Not enough law enforcement	94	6	0	188
Too much law enforcement	97	2	1	188
Black bears	98	2	0	191

[1] Ranked by mean score.
[2] Row totals may not equal 100 percent due to rounding.
[3] For overnight campers only.

Sea-Kayakers

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lem." Most issues or topics were found **not** to be a problem (Table 1). Among all problems listed, insect bites (reported by 51%) was the top-rated. Forty-four percent complained of inadequate toilet facilities at launch sites. About a third of all respondents reported each of 3 issues as a problem – rough seas that made travel difficult, bad weather, and meeting too many other watercraft. Too few launch sites on Lake Superior were cited by nearly one fourth of all visitors. In addition to insect bites (60%) and meeting too many other watercraft (54%), campers reported finding a high quality campsite (48%) and finding an unoccupied campsite (41%) as problems.

Even among the problems identified as relatively important, virtually none was rated as serious or very serious (Table 1). For example, while 51 percent of the respondents reported insect bites as a problem, only 8 percent of all respondents rated them as "serious" or "very serious." Most rated them as "a slight problem" (23%) or "a moderate problem" (20%).

Some of the issues identified as problems (insect bites, bad weather, rough seas) would seem not to be management oriented. However, managers can help mitigate these problems through the use of brochures, interpretive programs, and other information and education activities, making visitors aware of, and prepared to contend with, these conditions as they arise. A brochure for sea-kayakers, developed in 1988, identified these concerns and is currently being distributed. It also may be advisable to use local outfitters to dispense educational information to clients before they arrive at APIS for their sea-kayaking experience.

A major finding of the study is that nearly half the respondents never left the mainland shore to venture out among the 18 islands comprising the Lakeshore. For visitors who used the Meyers Beach entry point (103 respondents), for example, 75 percent used the shoreline only. For those entering at Little Sand Bay (49 repondents), 25 percent visited the shoreline only. All but one of the visitors launching at Bayfield/Red Cliff (45 respondents) visited at last one island. Shoreline-only visitors typically used the services of an outfitter and were day users. Many visited the popular Squaw Bay sea caves. Because the mainland shore, not the islands, is the destination for many sea-kayakers, different information, education, and interpretation programs may be needed for shoreline visitors and for sea-kayakers who explore the island resources.

For those visitors who did stop on at least one island, nearly all made at least one stop in the 6 inner islands; half stopped in the 7 middle islands, and nearly 20 percent visited at least one of the 5 outer islands. It also is important to note that use appears to be concentrated on only a few of the islands in each zone.

This project was an exploratory step on the way to designing and implementing a program to monitor sea-kayaking, as well as other watercraft use, in the Lakeshore. Monitoring is an important management activity, letting managers know over time whether physical and social conditions are getting better, getting worse, or staying about the same. While no particular issue appears to be a big problem *now* for sea-kayakers at the Lakeshore, managers are well advised to monitor change and be responsive to it.

Phelps is a Research Assistant and Lime is a Research Associate and NPS/CPSU Leader in the Department of Forest Resources, College of Natural Resources, U/MN, St. Paul 55108.

notes from abroad

Editor's Note: From time to time we get reports from scientists who have attended conferences abroad. In order to encourage submissions of this kind of news, a "standing head" will be used to cover these accounts. Recently David L. Peterson, research scientist with the NPS/CPSU at U/WA, presented papers at the International Symposium on Tree Rings and the Environment in Ystad, Sweden, and at the International Conference on Acidic Deposition in Glasgow, UK. Following are highlights from his report and a listing of the papers he presented.

By David L. Peterson

The International Symposium on Tree Rings and the Environment was the second major meeting for dendrochronologists and was a follow-up to the conference held in New York in 1986 ... truly an international meeting with 120 participants from 25 countries, only 8 from the U.S. I was the sole NPS representative at the conference.

Subject matter was wide-ranging, with many papers presented on dendroclimatology, most of these from Europe. There is increasing interest in this subject because of its connection to global climate change through evaluation of past climatic conditions.

Most papers focused on the relationship between annual growth and individual climate parameters (such as monthly precipitation), as well as reconstruction of past climate. However, 3 papers, including mine, focused on long term growth patterns. I presented the results of a study of whitebark pine and lodgepole pine in the Sierra Nevada of California. These high elevation species have had increasing basal area increment growth since about 1850, a pattern also found at a few other North American subalpine sites. One of these papers, presented by Keith Briffa of East Anglia, UK, showed there has been a similar growth increase at many sites in mountainous areas of Europe. These results created a great stir of interest and helped encourage discussions about additional studies of subalpine species.

The session on methodology revealed there have not been many new developments in analytical capability. Disagreement still exists as to what statistical approaches to use for time series analysis of tree growth data. A movement is growing to look at individual tree growth patterns, in contrast to the traditional approach of aggregating data by groups of trees. This approach is better for examining the variance in any particular dataset. Some progress has been made in the technology of measuring tree cores, particularly in the areas of image analysis and densitometry. Both technologies are still very expensive, although image analysis may be a viable alternative if the resolution of discriminating among tree rings improves.

A number of "applied" topics were discussed, such as the use of tree ring analysis to date old European structures (e.g. churches) as well as structures at a number of archeological sites.

* * *

The International Conference on Acidic Deposition in Glasgow attracted 800 people from 25 countries, mostly Europe and the US. Again, I was the only NPS representative. This meeting provided a forum for synthesizing much of the information collected on this topic over the past decade. It may well be one of the last meetings of its kind because of reduced funding in this area and a shift to interest in global climate change.

Considerable debate continues over the effects of acidic preciptitation and other pollutants on terrestrial ecosystems. Many of the "declines" that received a lot of publicity in the early '80s have now been explained in terms of other phenomena or have not been linked conclusively to pollutants. The forest decline issue in central Europe is hardly even mentioned anymore; many trees studied on permanent plots have reverted to a more healthy condition in the last few years.

The condition of red spruce in the eastern US continues to command much attention. Experimental evidence with seedlings has shown a weak link at best with pollution. Establishing cause-and-effect relationships between trees and pollutants has not been very successful because of the difficulty (or lack of interest) in working with mature trees. I presented a similar paper to the one I gave in Sweden; the results on tree growth increases in the Sierra Nevada contrasted with most of the other papers that focused on damage and declines.

The best presentations were on the effects of acidic deposition on aquatic systems and soils. There appears to be a great deal of evidence that acidification of lakes and some streams is occurring at least in some locations. This seems most prevalent in areas that have the highest sulfur and nitrogen inputs and the ecosystems with the lowest buffer capacity. There also seems to be good evidence of the potential for soils to have increased acidity and decreased nutrient content under long term acid deposition. This has not been manifested on a large scale, but may be in the next 50-100 years if deposition is not reduced or mitigated.

The conference also revealed some of the usual prejudices in this field. The Canadians were upset with the US for supposedly acidifying their lakes and damaging sugar maple. Many US scientists think the Canadians use their research and publications mainly as environmentalist propaganda. The Scandinavians continue to complain about pollution from continental Europe and Great Britain. Unfortunately there were few eastern Europeans there to discuss what really severe pollution damage is like. Many of the studies were inadequately designed to link pollutants with effects in a realistic context, or were somewhat biased in their interpretation (usually in favor of pollutant damage.)

* * *

I visited some of the parks in Norway and Sweden and did quite a bit of hiking in Hardangervidda National Park in central Norway. This park is at about 62 deg. latitude and entirely above treeline. It contains a wide variety of alpine plants in both wet and dry habitats, lots of lakes and streams, and some spectacular glaciers.

Park management in Norway is relatively passive. The trails are well-marked, but that is about the only sign of management presence. There are no visitor centers, parking lots, campgrounds, interpretive material, or park personnel. Everyone seems accustomed to this and they just put on their backpacks and take off for a hike.

The parks also are used extensively for grazing, mostly by sheep, and have been used for this purpose for hundreds of years. Obviously, this has affected the local plant communities. I also visited some natural areas in southern Sweden, the largest of which was Skaralid NP. Again, management is passive in most

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Tree Line Research in Gates of the Arctic NP
A Follow-up to Robert Marshall's Research

By Terry Droessler and Judy Alderson

When wilderness explorer Robert Marshall travelled in the central Brooks Range in the 1930s, he combined his enthusiasm for the scenic and wilderness values of the area with a scientific interest in the ecological relationships there. As a result, Marshall undertook tree growth studies in the North Fork of the Koyukuk, Alatna, and John River drainages in what today is Gates of the Arctic National Park and Preserve (Retzlaf and Marshall 1931, Marshall 1933, 1970, 1979, Glover 1986, Brown 1988).

Current interest in global change and the need for long-term data relating to climate change have led two agencies to investigate the potential use of Marshall's data for determining change at tree line in the central Alaskan arctic. Tree line is defined in this study as the northernmost trees that were located.

During summer 1990, the U.S. Environmental Protection Agency and NPS combined resources to sample sites at tree line within Gates of the Arctic NP. White spruce (*Picea glauca*, Voss) at tree line is sensitive to climate and may respond to global climate change. To detect field evidence of white spruce tree growth and tree line responses to climate, tree line location was mapped and tree cores were extracted to determine tree age and annual increment. Previous work by Marshall helped identify specific research sites. The tree increment cores collected, together with observations of tree line migration, should enable quantitative statements of tree growth and tree line migration response to recent past (post 1900) climate. The tree cores currently are being analyzed and results as well as observations will be published when completed.

The relationship between tree line location and climate has been based on correlational studies. There are several temperature-based guidelines that correlate with tree line location. For example, correspondence between the 10 deg. C. July isotherm and tree line location is discussed in Tranquillini (1979), Arno (1984), Larsen (1988), and Young (1989).



***Boreal Mountain** (left) and Frigid Crags Mountain (right) form the namesake "gates" in Gates of the Arctic NP. In this photo, looking south, the North Fork of the Koyukuk River flows in from the left and Ernie Creek flows in from the right. Tree lines on both waterway drainages were sampled, as shown on the map.*

The greatest climate warming is expected to occur at higher latitudes. According to predictions from General Circulation Models (GCMs) warming in the higher latitudes may be at least twice the global average (Houghton and Woodwell 1989). An increase in temperature would shift the 10 deg. C. July isotherm higher in latitude and altitude. If temperatures do increase and moisture is not limiting, tree line may advance in latitude and altitude at a faster rate, or advance where it previously was limited by climate. Previous studies of tree line in other areas in Gates of the Arctic have shown stable to advancing tree lines (Densmore 1980, Goldstein 1981, Odasz 1983, Cooper 1986, Lev 1987).

White spruce at tree line on the south slope of the Brooks Range and isolated clusters of balsam poplar (*Populus balsamifera*, L.) trees on the north slope commonly reproduce by vegetative means only (Lev 1987, Edwards and Dunwiddie 1985). Increased temperature may allow trees to flower and set viable seed. Migration rates could increase dramatically because seed dispersal distances are far greater than branch or root vegetative reproduction dispersal distances.

Marshall's Historical Records

The Robert Marshall Papers, archived at the Bancroft Library, U/Cal/Berkeley, contain ecological observations and tree growth data that Marshall collected on field trips. Marshall kept detailed field journals, including time and distance records and descriptions of where data were collected. The data include various ecological observations in addition to increment core tracings and diameter distribution and stocking information.

Marshall collected tree growth and sample plot information at and "below" tree line. He hypothesized tree growth to be limited by moisture, solar radiation, or temperature, and that tree line was not exclusively constrained by climate. Rather, he thought spruce trees may not have had sufficient time since the last glaciation to migrate to a climate controlled tree line.

Marshall attempted to advance tree line by planting white spruce seed plots beyond tree line (Marshall 1970). Paired plots were planted in 3 drainages, Grizzly, Kinnorutin and Barronland Creeks (located in Gates of the Arctic NP), to see if seeds would germinate and grow. Seed was sown on mineral soil (all vegetation removed) on one plot and on existing vegetation on a paired plot. For example, the 1930 Grizzly Creek planting (about 12 miles north of tree line) used

Notes From Abroad *(Continued from page 21)*

areas except for some recreational areas used for picnicking and group activities.

I saw heathlands as well as hardwood and conifer forests. The heathlands and other nonforested areas are used extensively for sheep grazing. The forested areas are managed for timber production as well as esthetic purposes. Intensive forest management is expected in most areas and there are as many as 8 thinnings prior to final stand harvest. Forest composition has changed a great deal over the years, with Norway spruce commonly planted in areas where it is not native. North American species are represented, particularly Douglas-fir.

I had the opportunity to see forest management practices in Great Britain, ranging from southern England to Scotland. Great Britain originally was 90 percent forested, a percentage now down to 10. In addition to the native Scots pine, a large number of non-native species have been planted. The most common are from North America: Sitka spruce, Douglas-fir, lodgepole pine, and noble fir. There is some effort by the British Forestry Commission to increase the amount of land containing forest, with an emphasis on plantations. This has some public support, but a lot of opposition too. Many people apparently prefer a more "open" landscape that is traditionally used for grazing. Reprints of the following two papers are available from Peterson at NPS/CPSU; College of Forest Resources, AR-10; University of Washington, Seattle, WA 98195.

"High elevation tree growth trends in the Sierra Nevada, California, USA," by David L. Peterson, Michael J. Arbaugh, and Lindsay J. Robinson, IN ***Proceedings of the International Symposium on Tree Rings and the Environment. University of Lund, Sweden.*** 1990.

"Growth trends of whitebark pine and lodgepole pine in a subalpine Sierra Nevada forest, California, USA," by David L. Peterson, Michael J. Arbaugh, Lindsay J. Robinson, and Berg R. Derderian, ***Arctic and Alpine Research,*** Vol. 22, No. 3, 233-243.

* * *

Dave Parsons, Research Scientist at Sequoia/Kings Canyon NPs, attended the international workshop "Earth System Responses to Global Change – Northern and Southern Hemisphere Contrasts" in La Serena, Chile Nov. 30-Dec. 4, 1990. Highlights of his report will appear in the Summer issue Notes From Abroad.

Arctic Research

(Continued from page 22)

seed collected approximately 4 miles south of tree line. Marshall suggested that if the seeds germinated and grew, he was advancing tree line by about 3000 years (based on the estimated 50 years to reach seed bearing age and a seed dispersal distance of 1000 to 1200 feet, roughly a migration rate of one mile in 250 years).

The Grizzly Creek planting site was revisited in 1938 by Marshall and no sign of seed germination was found. Sam Wright visited the Kinnorutin Creek and Barrenland Creek sites in August 1966 and again found no sign of trees (Wright 1969, 1973, 1988). A likely explanation is that the seed origin was inappropriate (Minnesota and Michigan) and seed viability was unknown for 2 of the 3 seed sources. The seed also may have been sown above climate controlled tree line.

The Barrenland Creek planting site was revisited by Sam and Billie Wright in 1968. They obtained 100 4-year-old white spruce seedlings from Dr. Leslie Viereck at the Forestry Sciences Lab in Fairbanks (Wright 1973, 1988) and planted them in one of Marshall's original Barrenland Creek plots. Sam Wright revisited the planting site in August 1989 and found 5 living seedlings, approximately 2 inches taller than at planting (S. Wright personal communication, Wright 1988). That there were any surviving seedlings after 21 years indicates the potential for trees to survive north of current tree line (the planting site is approximately 3 miles north of current tree line). That the trees were essentially the same size as at planting indicates a physiological limitation on photosynthesis. Wright (1988) ends a chapter entitled "Tree Planting" with the following:

"At present, in the arctic wilderness north of timberline, there is now a small grove of seedlings which have jumped three thousand years."

Tree Line Sample Locations

Marshall provided detailed descriptions of tree line locations where he extracted tree cores. Figure 1 shows 6 of Marshall's tree line sites chosen for this study.

Data Collection

For the 1990 field work, tree line sampling sites were located from a helicopter and by hiking. The helicopter was used to hover at low altitude and circle up drainages beyond tree line to help insure that the northernmost trees were located. Hiking from both the north and south helped insure that trees hidden by alder and willow brush were located.

Once located, the tree line position was recorded on topographic maps and photographs of trees were taken. Approximately 20 trees, 5 cm or larger at 1.5 m above the base, were cored at each site. Cores were extracted at the base and at 1.5 m height, stored in straws, and labeled for later measurement. The increment cores are currently being measured and analyzed; results will be published upon completion.

Management Implications

Baseline tree growth and tree line location data will help advance our understanding of a unique resource, the forest-tundra ecotone. It will also be important for monitoring future climate-induced tree growth and migration changes. Current and recent past white spruce demographics will be essential for interpreting response to recent past climate and for predicting possible future changes. Marshall's descriptions of tree line position in the 1930s provide one baseline for comparison. The data collected in the summer of 1990 will provide a current baseline for comparison.



***Looking north** at the northernmost trees on Loon Creek.*

Tree data may be useful as part of the international effort to study global change. The importance of arctic areas for global change research is becoming recognized. Regional assessments and studies can be coordinated and correlated through tree line work such as this, and through work planned in the Noatak National Preserve to the west of Gates of the Arctic. Predictions of tree growth and tree line migration response to future climate scenarios throughout the region may be possible.

Tree line information may be useful for park specific or regional retrospective analyses and future resource management interpretaive efforts. The potential impact on wildlife that show preference for forested versus brush/tundra areas exemplifies the use of tree line location information. In the near future, sparsely forested areas at the south of tree line may become heavily forested, thereby enlarging habitat ranges for northern woodland wildlife species.

Future Research and Monitoring

The acquisition of a portable Global Positioning System (GPS) would allow mapping of tree line and other features of the park in 3 dimensions and provide precise measurements for tree line advances or retreats. Because tree core information already has been collected, this would involve revisiting the sites with a portable GPS unit, standing next to each tree or feature of interest, and locking in the position with a GPS receiver. A single GPS unit will determine position within approximately 15 meters, multiple units within one meter. The accuracy of GPS equipment depends on the grade of the satellite signals available for civilian use at a given time (controled by the Department of Defense and called selective availability.)

Many factors acting separately or synergistically have been hypothesized as controling tree line location. Identifying the physiological limitation(s) for sexual reproduction, seed germination, seedling survival, and tree growth and maturation at sites varying in slope, aspect, drainage, etc., is critical for modeling the response of tree line in specific drainages and regions to climate change.

The tree line environment is subject to natural cycles on various time scales and to anthropogenic influences that may confound the effect of global warming. Determining the effect of rising CO2 levels from rising temperature levels may prove challenging. If temperature is a critical factor, tree line may advance beyond the continental divide to the north slope, reducing tundra areas to the higher elevations of the continental divide.

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(Continued on back cover)

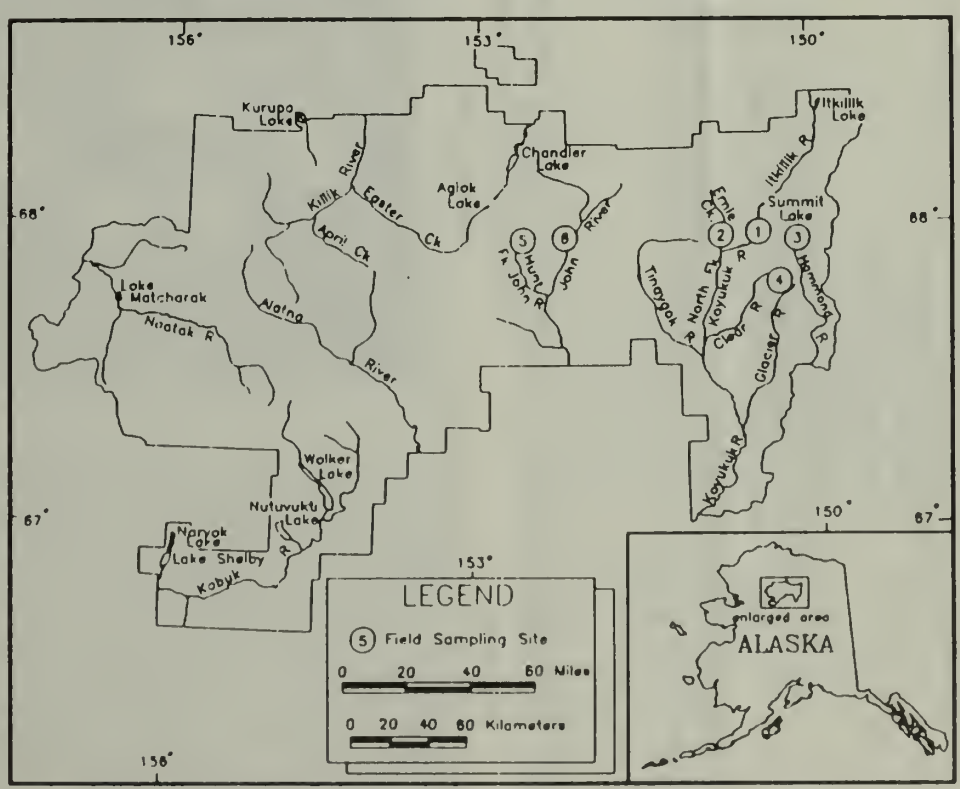


***Figure 1.** Map of Gates of the Arctic National Park and Preserve showing the position of tree line study sites in the park. 1) North Fork of the Koyukuk River, 2) Ernie Creek, 3) Hammond River, 4) Clear River, 5) Loon Creek and 6) John River.*

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New Plant Species Discovered in Guadalupe Mountains National Park



***A "group picture"** of the new find* – Viola guadalupensis, *clinging to a limestone cliff in Guadalupe Mountains NP.*

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Park Science, A Resource Ma...

PARK SCIENCE
A Resource Management Bulletin

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Effects of Prairie Fire On Archeological Artifacts

Editor's Note: How do the caretakers of a "mixed site" (i.e. cultural and natural resources) decide on management techniques that speak in a balanced way to the complex needs of such a site? The following article describes how the stewards of one such NPS area are addressing this delicate and demanding task.

By Robert W. Seabloom, Rodney D. Sayler, and Stanley A. Ahler

The Knife River Indian Villages National Historic Site (KNRI) was established to preserve the historical and archeological resources associated with the Mandan/Hidatsa (Plains) Indians and early white exploration of the west. The park harbors evidence of several centuries of human activity. It is noted for its earthlodge village sites (Fig. 1) and evidence of early agricultural development on the northern great plains.

Lewis and Clark and other Euro-American explorers visited the location and recorded important observations on the life of the Plains Indians. Modern cultural resource studies have revealed a wealth of archeological artifacts and historical sites within the 520 ha area.

The park, a linear tract on both sides of the Knife River, is comprised of floodplain with a forest type known as "Missouri River bottomlands," dominated by green ash and boxelder. In addition, higher elevation terrace zones consist of native prairie sites and former cropland.

The park is charged with three major objectives:

(1) to recreate the 1804 historic scene depicting earthlodge villages,

(2) to protect park resources from human and natural impacts, and

(3) to maintain, where compatible, the natural habitat.

Currently, all fires are suppressed. However, historical evidence demonstrates that natural and artificial fires were regular events in the mixed grass prairie, perhaps occurring in 5 to 10-year frequencies. In recent years, fire suppression has resulted in a steady buildup of grassland and riparian fuel loads, colonization of disturbed soils by invading plant species, and natural vegetative growth.

This situation has increased the chances of an uncontrolled wildfire which potentially could endanger the park's cultural resources as well as surrounding private property. However, it was not considered possible to design and implement a fire management plan to achieve the desired ecological benefits without first determining the impacts of grassland fire on significant cultural resources. Although over 20 years of fire ecology research allows ecologists to predict impacts on biotic communities, the possible impacts of prescribed burning on archeological resources are not well known.

Prairie Fire Research

A team of ecologists and archeologists from the University of North Dakota conducted studies in 1988-89 to (1) determine potential impact of prescribed burns at KNRI on its archeological resources, and (2) develop a recommended burning program for vegetation management at the park.

The impacts of prairie fires on 10 representative archeological materials were evaluated in 4 experimental plots established at the University of North Dakota's Oakville Prairie Natural History Area, a native mixed grass prairie near Grand Forks (Fig. 2). Two separate burns were accomplished in October and November, 1988, and the test artifact materials were collected and analyzed for a variety of changes – in color, weight, structure, and morphology.

The North Dakota Study is one of the first to indicate that certain kinds of artifacts will be altered by fire in grassland settings, necessitating careful site management.

The experiments indicated that fire-related impacts to buried artifacts are negligible, but effects on surface-exposed artifacts will be significant, depending on artifact type and size. Virtually all surface artifacts will be scorched and smoke blackened, and the duration of this effect is unknown. Organic items, such as bone and antler remains, will be substantially altered by blackening and charring. Wood materials will be charred or consumed. Shell will be fractured or disintegrated. Many chipped stone items (flaking debris and tools) will be spalled (splintered or chipped) and potlid-fractured. Pottery will not be damanged structurally, but surface color may be altered. Small lead and glass items will be partially or fully fused or melted (Fig. 3). The structure of larger stone items such as natural rock, flint cobbles, and larger stone artifacts generally is not affected, although localized spalling may rarely occur.

The North Dakota data are unique. The majority of earlier reports on the effects of fire on artifacts have dealt with forested habitats, generally in the American Southwest or California. Few controlled studies have been conducted. The North Dakota study is one of the first to indicate that certain kinds of artifacts will be altered by fire in grassland settings, necessitating careful site management.

Prairie fires probably have little, if any impact on ceramic materials or cobble-sized rocks, a conclusion of significance to archeological interpretation. For example, fire-cracked rock in a grassland setting prob-



Figure 1. Aerial view of the Big Hidatsa earthlodge village. A light snow cover helps outline the earthlodge depressions and the modern road.

Concluded on page 3

PARK SCIENCE

NATIONAL PARK SERVICE

WINTER 1991

A report to park managers of recent and ongoing research in parks with emphasis on its implications for planning and management

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Contributors, Please Note!

Park Science has deadlines: Nov. 15 for Winter issue; Feb. 15 for Spring issue; May 15 for Summer issue; Aug. 15 for Fall issue. Copy that comes to the Editor after these dates usually cannot be used until the following issue.

Park Science also has only 24 pages per issue, thus adding "space" to "time" as an editorial constraint. Your Editor suffers over these limitations as much as you do. Alas, neither tears nor ulcers can change them.

Editorial

As an editor, looking back from the 10th anniversary of the publication, I felt an urge to take some notice of ***Park Science***'s first decade. The editorial page seemed the most likely place to do so, and with that in mind I browsed through old issues, hoping to find some former words of my own that simply cried out for ceremonial recognition.

I didn't.

What I *did* find, however, was a couple of inclusions in the Spring 1983 issue, the re-printing of which is more than a mere salute to the past. One is the editorial by Peggy Herring on WHY scientists should write well, and the other, associated piece, is the article by Jim Wood on HOW to write scientific material for general public consumption. To print them again is a service to both the writers and the readers of ***Park Science.***

So here are the words of Peggy Herring, who was a student of mine in a Natural Resource Communications class at Oregon State University, and who has since become an immensely successful science writer, with her own clientele and production capabilities and a wide sphere of influence as a result of having practiced what she preached.

The succinct advice of Jim Wood appears on page 13.

By Peggy Herring

I am a biologist and I want to learn to write.

I believe that the privilege of doing research carries with it a responsibility for interpreting technical ideas for the interested public who may be footing the bill.

Scientific research too often is a facts-and-figures account of research and management. This is useful for people who already are specialists in the field, but it does not inspire those who have no confidence in themselves to understand scientific concepts. Scientific policy affects all citizens, and we should have access to these ideas. We need this information to help us make decisions and understand their consequences.

Topics of science can be presented clearly and simply without losing their accuracy. *Precision is relative to the needs of the audience.* With *modified precision* (NOT compromised accuracy) the most obscure technical idea can become readable, understandable, to a non-scientific audience.

Also, there is an added value in viewing research in less detail. Focus is broadened so that trends in thought and relationships to other work become clearer.

I have one more personal reason to want to learn to write well. The commitment to interpret a certain topic of science is a demanding and effective way of *learning* about the subject. To collect the small puzzle pieces of research and organize ideas into a larger design is to experience the joy of discovery. This organizational process would be the same if the product were to be a written article, a videotape, or an illustrated display. I am sometimes more fluent in drawing a picture than I am in composing the thousand words it represents. But to write clearly is to think clearly, and so interpretation becomes discovery.

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Effects of Prairie Fire On Archeological Artifacts

(Continued from page 1)

ably can be interpreted as a product of cultural rather than natural processes.

In addition, while surface deposits of bone and chipped stone can be expected to undergo significant alteration, the degree of alteration in these items is apparently less severe than can be caused by fire-related cultural processes, such as material from an open fire hearth.

These data will help the archeologist interpret the significance of several classes of archeological materials.

Site Management

The KNRI study indicated a potential conflict between the objectives of vegetation management to recreate the original native prairie setting, and protection of surface archeological resources. However, prior surveys demonstrated that artifacts are not randomly distributed on the park, but are concentrated in their highest densities at three major historic period village sites. Consequently, a management plan was developed that provided for differering levels and timing of fire treatment, based on surface artifact density.

The phased burning program that was recommended recognizes several categories of artifact densities and relative importance or sensitivity to burning.



Figure 2. *Test burn conducted at the University of North Dakota's Oakville Prairie.*

The phased burning program that was recommended recognizes several categories of artifact densities and relative importance or sensitivity to burning.

Specific recommendations were that:

(1) Major KNRI village sites not be burned until a thorough and professional collection of surface-visible artifacts is completed and preserved for future analysis;

(2) Archeological sites at KNRI with moderate artifact densities be surveyed to determine whether surface collection is warranted to mitigate fire damage; and

(3) Burning and other vegetation management programs may begin as soon as feasible on areas and portions of the park that have low artifact densities, archeological sites ineligible for the National Register of Historic Places, or sites not susceptible to fire damage.

In addition to prescribed burns, gradual logging, mowing, site-specific chemical treatment, and even grazing may be used to manipulate vegetation in several problem areas at KNRI that cannot easily be burned.

However, some management practices may be difficult to implement on such a small area without creating additional disturbance to natural vegetation (e.g. fence construction, trampling by bison and horses). Consequently the prudent development of a prescribed grassland burning program still remains the most feasible tool to attain the management goals of the park.

The KNRI study indicated a potential conflict between the objectives of vegetation management to recreate the original native prairie setting and protection of surface archeological resources.



Figure 3. *Effects of prairie fire on test artifacts: Unburned glass beads and lead sinkers on left, fire damaged samples are shown on the right.*

Seabloom is a professor of biology at the University of North Dakota; Sayler is director of the Institute of Ecological Studies at U/ND; Ahler is associate professor of anthropology at U/ND.

2 LATE CALENDAR ITEMS

Feb. 22-23, Designing, Maintaining and Restoring the Native Landscape III, at Portland Community College, Rock Creek Campus, Portland, OR. Contact: Mark Wilson, (503) 222-0134.

July 21-25, Quadrennial Meetings of the International Association for Landscape Ecology (IALE), at Carleton College, Ottawa, Ontario, Canada. First time ever held in North America. Call for papers from Dr. Grey Merriam, (613) 788-3859.

Sociological Contributions to Everglades Backcountry Use Management Plan

By William P. Stewart, Ray W. Snow, and Mark I. Ivy

Of the 1.4 million acres comprising Everglades NP, all but approximately 20,000 acres can be considered backcountry, much of it relatively inaccessible because of dense Mangrove thickets, pinnacle rock and extensive mud flats. Most of the use is seasonal, occurring in the drier winter months when insect pests, heat, and humidity are less intense.

Prior to the 1960s, recreational use of Everglades consisted largely of day-use boating and fishing. Opportunities for overnight camping in the backcountry were limited due to extreme scarcity of high, dry ground. The increased demands for overnight camping during the 1960s led managers to construct "chickees" (i.e., covered wooden decks approximately five meters square, raised above the water on pilings) which has its origins with the Miccosukee Indians. Chickees allowed flexibility in establishing additional sites while minimizing impacts to natural resources. Continued increases in backcountry use during the 1970s led to the initiation of a voluntary overnight permit system in 1977, which was made mandatory in 1983. The purpose of the permit system was to establish campsite capacities, provide data to determine use levels, extend contact between the NPS backcountry staff and visitors, and to aid in search and rescue operations within the park. A backcountry function in Resource Management was established in 1978 and a Backcountry Management Plan adopted in 1981. Backcountry use continued to increase throughout the 1980s, giving rise to concern about the effectiveness of policies and regulations stemming from the 1981 plan.

The primary goal of backcountry use management is to provide park visitors access to a variety of primitive recreational opportunities without incurring unacceptable change to the resource or disturbance to the experiences of others. If we were to revise adequately the 1981 plan, it was clear that we needed sociological information regarding the user experience.

The Backcountry User Study

To provide this sociological information, a study of wintertime backcountry users at Everglades NP was begun in 1988 and recently was completed. This study was formulated as a cooperative agreement between the NPS and Texas A&M University. After several telephone consultations and an onsite orientation meeting with researchers from both Texas A&M and the CPSU at Virginia Polytechnic Institute, the following study objectives were developed: (1) to identify the overnight and day users of the park's backcountry; (2) to determine the motivations, expectations and preferences for overnight and day users; (3) to measure overnight and day users' levels of satisfaction with their Everglades experience; (4) to evaluate overnight users' reaction to the present permit issuance and itinerary system; (5) to develop a sociological monitoring system that could be used by the park staff; (6) to provide the initial database to be used in backcountry travel simulation models; (7) to suggest management actions that best meet social needs.

Full cooperation between NPS and Texas A&M was essential. Development of the research proposal was a negotiated effort involving staff people from several ranks at Everglades and Texas A&M researchers. This research involved sending a map of the Everglades backcountry to each of the sampled users, requesting the respondent to trace the route of their trip. The Everglades' staff, along with the graphics specialists from the NPS Harpers Ferry Center, developed an 11×17-inch map insert for the questionnaires. Part of the sampling procedures required a Graduate Research Assistant from Texas A&M to conduct face-to-face interviews with daytime users of the backcountry. During the three months of the study, the Everglades' staff provided park housing and office space for the student, and access to computer equipment, secretarial and mail assistance, along with facilitating lines of communication between the student and park employees.



***Current-day "chickees"** of Everglades National Park have their origins with the Miccosukee Indians. Photo by Garrett Moynihan.*

A first draft of the technical report was submitted to Everglades NP in October 1989. During December 1989, the investigators from Texas A&M, along with Jeff Marion (Unit Leader and Research Biologist, CPSU at VPI), met at Everglades to discuss the study, the final report, and policy recommendations emerging from the study.

Backcountry User Study Synopsis

Since overnight and day users are found in most areas of the park's backcountry, information was needed from both of these user types. As a result, two concurrent surveys were administered during January, February and March of 1989. The results were based upon 482 day users (representing an 83% response rate) and 380 overnight users (representing an 81% response rate) who were randomly sampled and mailed-back completed questionnaires. The findings indicated that the characteristics of Everglades backcountry users represent a diverse array of previous backcountry experience, motivations, preferences, behavioral patterns and socio-demographic attributes. The majority of backcountry visitors surveyed achieved high levels of satisfaction with most aspects of their experience.

Of the respondents to the day user survey, 84 percent of the motorboaters and 46 percent of the canoeists came from Florida. Of the respondents to the overnight user survey, 89 percent of the motorboaters and 36 percent of the canoeists reported Florida as their state of residence. *These data indicated that the Everglades backcountry is a popular resource for Florida motorboaters and a nationally recognized resource for canoeists.*

By a wide margin and across both samples, viewing wildlife surpassed all other reasons as the most popular motivation for visiting Everglades backcountry. Compared to canoeists, motorboaters were more likely to emphasize releasing tensions and fishing as motivations for visiting the backcountry. Compared to motorboaters, canoeists were more likely to emphasize solitude and physical exercise as motivations.

The issue of crowding is typically a concern for backcountry recreation managers. Respondents were asked to report their satisfaction level with the number of other *people* encountered during the daytime; 12 percent reported dissatisfaction. However, when asked to report on their satisfaction with the number of *motorboats* encountered, 46 percent of canoeists compared to 11 percent of motorboaters, expressed dissatisfaction. When asked to report on their satisfaction with the number of canoes encountered, 4 percent of canoeists, compared to 11 percent of the motorboaters, expressed dissatisfaction. Also when asked to report on the degree of crowding during the daytime, 63 percent of canoeists, compared to 39 percent of motorboaters, expressed some feeling of crowding. These data suggest that if one were to be concerned with potential crowding problems in the backcountry at Everglades NP, reducing the number of encounters would be less relevant than reducing the likelihood of encounters between different types of groups.

The compliance rate to the permit itinerary system for overnight use was estimated, in part, based upon the respondents' traced route of their trip on a map enclosed with the questionnaire. Seventy-one percent

Concluded on page 5

Parks, Pollution, and People: An International Conference on Management Of Protected Areas Under Atmospheric Emission Impact

By John D. Peine

The objective of the conference held June 3-9, 1990, at Krkonose (Giant Mountains) NP, Czechoslovakia, was to explore the impacts of air pollution on national parks and other protected areas, with special attention to the biological diversity of forest ecosystems, in order to prescribe practical measures to be implemented immediately, before the sources of pollution can be reduced or eliminated.

International review papers were presented, dealing with topics such as an overview of air polluted environments in central and eastern Europe, review of critical loads and levels of air pollutants, natural heritage sites and climate change, forest dieback and atmospheric pollution in Europe, impacts on aquatic systems, on soils, and on recreation and tourism. Concurrent sessions dealt with air pollution related problems in specific national parks and like reserves in Norway, Nova Scotia, Canada, Czechoslovakia, Poland, what was then East and West Germany, and the United Kingdom.

The intended output of the conference was to establish practical guidelines for management of protected areas subject to emission impacts. These yet-to-be-published guidelines will be based on papers and case studies prepared in advance for discussion, with the provisin of approval by the conference. Problems and some solutions were examined during a field day excursion into the Krkonose NP.

My role was to provide a case study of a national park in the U.S. with related biogeographic characteristics to that of eastern Europe as a point of comparison of how a park-level air quality management program has been conducted in the U.S. The intent was to look, in broadest terms, at the management program, ranging from emission control standards to monitoring, research of environmental effects, education, and mitigation activities. I altered my prepared presentation, which followed a field day, in order to draw more direct comparisons between Great Smoky Mountains NP and Giant Mountains NP.

As in the Smokies, the forests in Giant Mountain park are difficult to assess in terms of the adverse impact from air pollution because of the exacerbating influence of a high tree mortality from insect infestation. At Giant Mountains there has been a major bark beetle infestation of Norway spruce trees. Air pollution effects are further complicated by the fact that the vast majority of the park's forests are a monoculture of Norway spruce that were planted 50 to 80 years ago almost universally over the landscape, establishing the potential for stress associated with marginal nutrient and climatic conditions and a high degree of vulnerability to insect pests and pathogens. Although the pollutant loading is significant in the park, no papers were presented that conclusively demonstrated a direct cause/effect relationship between air pollution and vulnerability to mortality related to insect infestation, which is the working hypothesis concerning the forest decline in the park.

Dead and dying trees currently are being removed via a clearcut logging operation with poor success rate of tree regeneration following these operations. A spirited and emotional debate occurred during the field trip between the newly elected park superintendent and the forester in charge of logging operations in the park. It was a clear demonstration of the emerging philosophy to manage parks based on ecological principles as opposed to the entrenched policy associated with land management practice to remove diseased trees. The ecologists had grave doubts as to the wisdom of massive landscape disturbance associated with the logging operations.

The very fact that the debate was going on openly, in front of conference attendees, was an extraordinary event, considering that the previous park superintendent had only recently been released from prison, where he had been sentenced to 8 years for criticizing government plans to build yet another ski resort in the park.

The challenges facing the management team at Giant Mountain NP are formidable in the light of the magnitude of air pollution loading and the desperate need to restore natural forest ecosystems in a polluted environment of depleted soil nutrients.

I view the conference as an extremely important and personal learning experience – observing the struggles these enlightened leaders in easter Europe are facing. We in the U.S. NPS should open communication with these people, who are at the forefront in trying to maintain and restore ecosystems in national parks. The difficult lessons they are learning will be applicable in the U.S. National Park System in the future. There is much to learn from our European colleagues about our own future.

Peine is Science Administrator at the Uplands Field Research Laboratory, Great Smoky Mountains NP.

Everglades Backcountry *(Continued from page 4)*

of backcountry trips were in compliance with their permit itinerary. Thus, in terms of permit itinerary information being valid indicators of site-specific use information, it should be recognized that there were substantial discrepancies between recorded and actual use of the backcountry campsites.

The effect of *noncompliance* is an important consideration at Everglades, since designated campsites are relatively small. When overnight users were asked if they were bothered by campers who were not complying with the itinerary system, 10 percent responded that they *were* bothered. Another item was directed at respondents who had reported sharing their site with non-complying campers; the results indicated that campers who deviated from the itinerary of their permit can have a positive (3%), negative (11%), or neutral (9%) effect on other campers (percentages based upon the complete sample of overnight users). Thus, in terms of the sociological impact of permit noncompliance, the proportion of overnight visitors who were negatively affected by noncomplying campers was about one-third the proportion of noncomplying campers.

Use of campsites by day visitors also was a concern and could be related to the amount and quality of impacts. Of the respondents who were day users, 27 percent reported that they stopped at a backcountry campsite area and of those that stopped, 43 percent reported that at least one person in their party used the restroom facility on the site.

Backcountry User Study Conclusion

The recommendations from this study were based upon the results of the study, the effectiveness of policies at analogue park areas, the collective professional judgments (as reported in literature) of scholars and land managers associated with outdoor recreation, and the authors' past experiences and opinions. The suggested order of importance of the recommendations was: (1) enhance and expand the diversity of recreational experiences afforded by the park's backcountry; (2) expand the number of designated sites within close proximity to trailheads; (3) maintain the current fixed itinerary system; (4) maintain and improve backcountry trip planning facilities; (5) adopt an advance reservation system for allocation of a portion of user nights; (6) modify the pumping schedule for sanitary facilities at heavily-used backcountry sites.

Stewart is Assistant Professor in Texas A&M's Department of Recreation, Park and Tourism Sciences, College Station, TX 77843-2261; Snow is Natural Resource Management Specialist at Everglades NP; Ivy recently completed a Masters degree at Texas A&M. For a copy of the technical report write the first author.

In the Next Issue

"Reclamation of Abandoned Mines at New River NR, Gouley River NRA and Bluestone NSR" by Carol A. Pollio; Sea-Kayakers at Apostle Islands National Lakeshore: Summary of a 1989 Exploratory Study," by Carolyn C. Phelps and David W. Lime; "Chiricahua Mts. Annotated Bird Checklist" by Kathy L. Hiett, R. Roy Johnson and Michael R. Kunzmann; "Using GIS for Assessment and Forecast of Impacts From Dredging and Oil Transport on NPS Barrier Islands," by Samuel Patterson and Richard Dawson; "Effects of Stocked Fish on Naturally Baren Mountain Lake Communities," by William Liss and Gary Larson; and "New Perspectives in Science," an essay by William E. Brown.

Red Wolves Thrive at Gulf Islands

By Ted Simons, John Weller,
Robert Esher and Dwight Bradshaw

The red wolf (*Canis rufus*) is the native wolf of the Southeast (Nowak 1979). Originally, it inhabited forests and swamps from central Texas to the Atlantic and from the Gulf Coast to the Ohio Valley and Pennsylvania. Unlike larger grey wolves (*Canis lupus*) which form packs of eight or more individuals, red wolves live in small family groups.

The red wolf is an opportunistic predator that preys primarily on small mammals. Studies in east Texas and Louisiana indicated the wolves feed almost exclusively on rabbits (*Sylvilagus aquaticus* and *S. floridanus*), nutria (*Myocastor coypus*) and cotton rats (*Sigmodon hispidus*) (Shaw 1975; Carley 1975).

The red wolf was extirpated from most of its range by the 1930s, although it survived in isolated pockets in the lower Mississippi Valley until much later (Wolfe 1972; Paradiso and Nowak 1972). The last wild wolves inhabited coastal prairies and salt marshes in east Texas and Louisiana. All the red wolves alive today are descendants of 15 individuals trapped in east Texas in the late 70s to form the nucleus of a captive breeding program (Parker et al. 1989).

Extinct in the world for almost 15 years, red wolves were returned to a portion of their former habitat in 1987, when eight wolves were released at Alligator River National Wildlife Refuge – the first step in an ambitious restoration program directed by the USFWS. By that time all the remaining wolves were second or third generation captive reared animals. Clearly the transition to independence in the wild would be difficult.

In 1988, the red wolf recovery team approached the NPS about using Horn Island, a 1300 ha wilderness area within Gulf Islands National Seashore, as a site to propagate wild red wolves (Parker 1987, 1988). Objectives of the proposed 5-year project would be to release a pair of wolves on the island, study their biology and their effects on the ecosystem, and use any wild offspring produced in restoration projects at Alligator River or other mainland sites. The hope was that wild reared wolves would have a higher survival rate than animals born and raised in captivity.

A recently completed 3-year baseline study on the island's small mammal populations (Esher et al. 1988) had raised concerns about the effects on island vegetation of introduced rabbits and nutria, and this fact, together with the hope of contributing to the recovery of the wolves, caused Supt. Jerry Eubanks to approve the wolf recovery project in the fall of 1988.

Two adult red wolves were flown to Mississippi from Alligator River NWR, NC, on Jan. 10, 1989. The male had been raised at Audubon Zoo in New Orleans, the female at the captive breeding program run by the Point Defiance Zoo in Tacoma, Wash. When they were brought to Horn Island, the male was five years old, the female, six. They were released into a 15 x 15 holding pen on Horn Island and fed fresh meat (deer, beaver, nutria, and rabbits) daily.

They quickly acclimated to their new surroundings and, while still in the pen, the female became pregnant and gave birth to seven healthy pups (4 males and 3 females) on May 6. On July 12, the pups were transported to Ocean Springs, where transmitters were surgically impanted. Their weights ranged from 4.4 to 4.8 kg. On July 28, the wolves were captured, given their final worming and vaccinations, and weighed. The female weighed 25 kg, the male 33.7 kg, and the pups averaged 6.3 kg (5.7-6.5 kg). All nine were released into the wild on July 31, 1989.

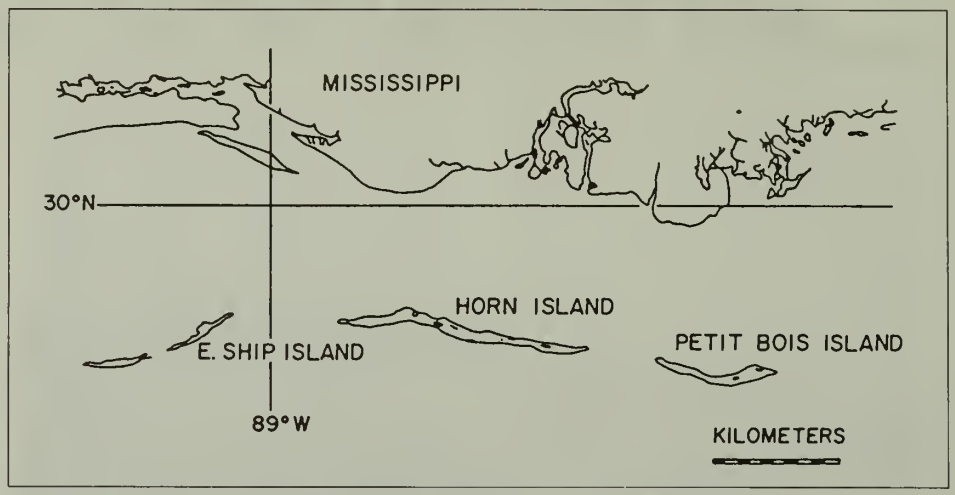


Figure 1. *Horn Island is a 1300 ha wilderness area located 10 km off the Mississippi coast.*

An on-going research project has provided information on the biology of the wolves and their effect on the island ecosystem over the past year.

Radio telemetry studies of the wolves' movements revealed that within a month of their release the adult wolves were hunting successfully and regularly traversing the entire 22 km length of the island. By the time the pups were five months old they were accompanying the adults on extended nightly hunting trips.

Monitoring of the small mammal populations has continued on a bi-annual basis, using a combination of live trapping grids, baited tracking stations, and unbaited cross-island tracking transects. These studies have documented changes in populations of several species. Wolves are excluding rabbits, nutria, and raccoons from open habitats. Nutria, which once foraged extensively on sea oats in the primary dunes, now are restricted to marsh habitats and their numbers probably have been reduced as well. Raccoons now are found almost exclusively in forested habitats and their numbers also may have been reduced. Rabbit numbers appear stable, although wolf predation apparently is causing a shift in the population age structure toward younger animals.



Figure 2. *Resources Management Specialist Gary Hopkins assists Biological Technician Robin Tillman in vaccinating a 10-week-old red wolf pup.*

We hope to monitor the secondary effects of these changes (e.g. the response of the vegetation to reduced grazing by nutria and rabbits or the response of sea turtle, alligator, and osprey populations to reduced predation by raccoons) in the years ahead. Food habits studies indicate that the wolves are feeding primarily on rabbits (70% of diet), raccoons (15%), and nutria (10%). The remainder of their diet includes vegetation, insects, fish, crustaceans, and birds.

The original plan for the Horn Island Project called for maintaining a single pair of adult wolves on the island and removing any pups produced each winter for eventual release at Alligator River or mainland sites. That plan was modified last winter due to the large number of pups produced and the death of the adult female.

The adult male and two male pups were trapped in January 1990 and send to Alligator River. The remaining five pups were left on the island where they have thrived over the past nine months. These five wolves, now full grown, were to be trapped in November 1990, and one female selected to remain on the island. She will be paired with a new adult male this winter in the hope that they will produce another litter of pups next spring.

One female will be sent to Great Smoky Mountains NP as part of a new project set to begin there in January 1991. Plans are underway to release red wolves into the Cades Cove area of the park as part of a research project to assess the suitability of the park as a restoration site. The remaining female and two male wolves from Horn Island will be sent to Alligator River for eventual release on the refuge there. It is hoped that the skills and wild instincts developed by these animals on Horn Island will improve their chances of survival at mainland sites.

Horn Island, Miss., appears to be an excellent place to rear and study red wolves. The wolves removed from the island in January were in superb condition and the transition from captivity to the wild in these animals appears complete. In spite of the fact that there are 20-30,000 visitors to Horn Island each year, no encounters or sightings of red wolves have been reported.

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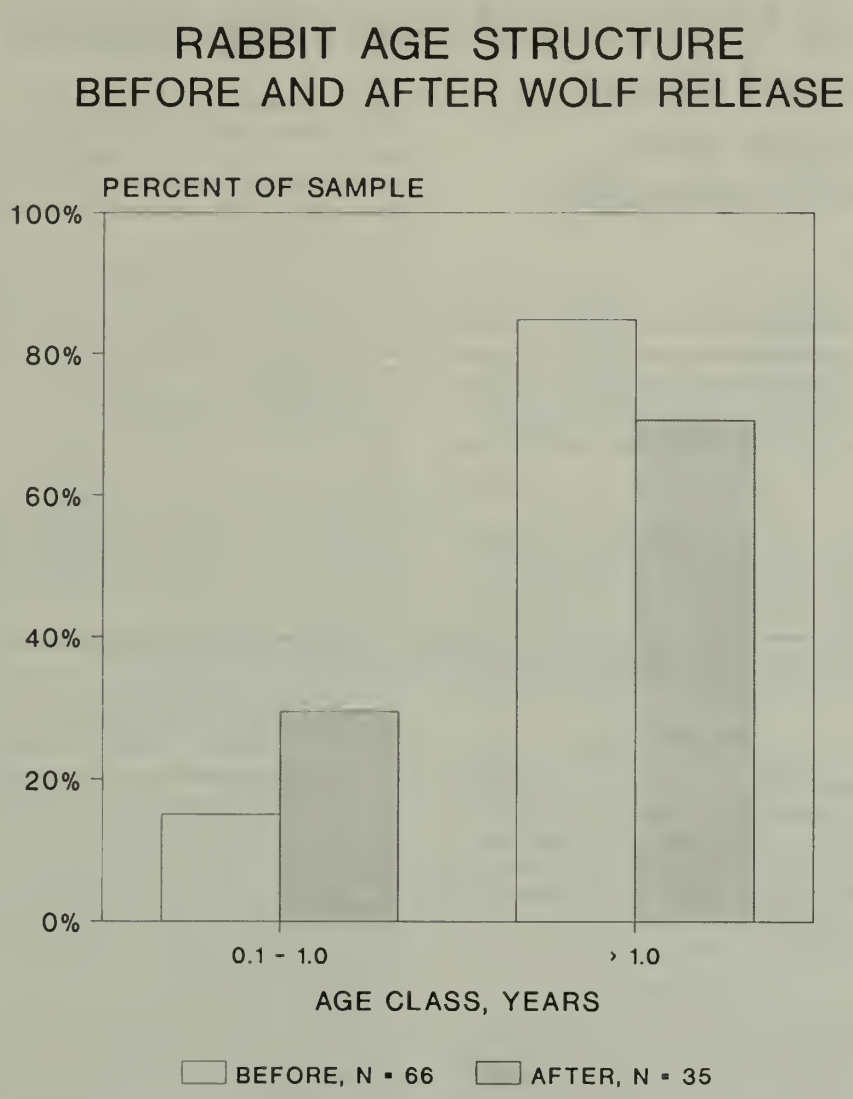


Figure 3. Comparison of age of cottontail rabbits on Horn Island before and after red wolf release.

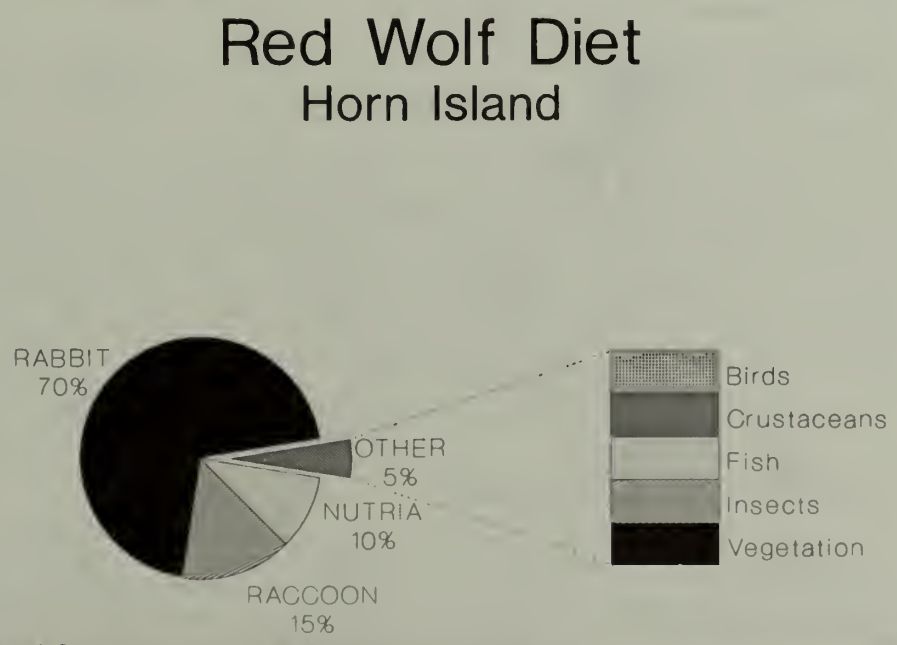


Figure 4. Composition of red wolf diet August 1989 - August 1990, n = 91.

Research on the prey populations is providing new insights into the role of predators in ecosystems and the effects of exotic herbivores on barrier islands. We believe that, as more data become available from this and other projects, biologists will be able to make better decisions on the management of this and other large carnivores.

Simons is a research biologist and Weller a biological technician at Gulf Islands National Seashore; Esher and Bradshaw are research biologists with Mississippi State University.

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New Plant Discovered in Guadalupe NP

Discovery of a new species, *Viola guadalupensis*, in Guadalupe Mountains NP, was announced at a press conference held the first morning (November 12) of the Gerorge Wright Society conference in El Paso, TX. Brent Wauer, a park ranger at Guadalupe Mountains, stumbled upon a small population (about 35) of these yellow violets growing on a limestone cliff in a remote canyon while he was exploring on his day off.

This was March 22, 1987. After an exhaustive study and chromosome check, Dr. Michael Powell, a botanist at Sul Ross State University in Alpine, TX, concluded more than 3 years later that this was indeed a new *Viola*. Only two other violet species, both blue-flowered, are known from the park. Wauer speculates that *V. guadalupensis* might be a relict species from wetter times in the past 8-10,000 years.

At the press conference, Regional Director John Cook unveiled a painting of *Viola guadalupensis* by Santa Fe artist Steven Boone. A color poster of this painting is available from the Carlsbad Caverns-Guadalupe Mountains Association at Carlsbad. Cook commended on the value of national parks for sheltering diversity of plant and animal life, including rare forms such as this new violet. He said it would be an immediate candidate for endangered species status.

(picture in next issue)

Yellowstone Workshop:

Ungulate Populations Models and Carrying Capacity

Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintroduction

By Francis Singer

A workshop to reconsider the subject of elk and bison carrying capacities in Yellowstone NP and to predict the effects of the dramatic events of 1988-90 was held in the park April 5-7, 1990. The "dramatic events" included the burning of 30 to 50 percent of the park's ungulate winter ranges during the large fires of 1988. The fires and drought of 1988, followed by a severe winter, precipitated a large migration of elk and bison from the park, large harvests of both elk and bison in Montana, and large winterkills. Approximately 24 to 26 percent of the northern elk herd winterkilled and 14 to 16 percent of the elk herd was harvested.

Public concern over the extent of the winterkill prompted a large fund raising effort by the Rocky Mountain Elk Foundation. In cooperation with the USFS and the NPS, 7,100 acres of private lands on historic winter ranges were purchased (Fig. 1) with a combination of private and federal appopriated funds. In 1987, the Northern Rocky Mountain Wolf Recovery Plan proposed restoring wolves to Yellowstone and adjacent public lands. The USFWS and NPS were directed by Congress to determine how wolves would affect their prey in the park and big game hunting in areas around the park (Wolves for Yellowstone? 1990).

The Concept of Ungulate Carrying Capacity in Yellowstone

During the droughts of the 1930s, Yellowstone Park managers calculated carrying capacity for elk of the northern herd at 7,000 to 11,700, based upon range methods used for domestic livestock. These criteria have since been abandoned for use with free-ranging, native ungulates. The concept of *economic* carrying capacity or the level of plant/animal ratios that produce the most gain in animal productivity prevailed in the early thinking. Early perceptions that elk numbers exceeded estimates of carrying capacity prompted herd reductions in the period 1932 to 1968. Douglas Houston (Houston, 1982) applied the concept of *ecological* carrying capacity – the dynamic equilibrium between native ungulates and their vegetative food base – to the northern elk herd. Based on the herd's 1968-1975 population growth curves, he estimated an ecological carrying capacity of 17,000: on 1969-1976 populations, 15,000. Merrill and Boyce (Merrill et al, 1990), using methods similar to Houston's, calculated an average carrying capacity of 15,000 elk for the period 1968 to 1988. Any number established for carrying capacity is beset with pitfalls for the unwary, since carrying capacity levels may be modified by winter severity, climate, and habitat changes.

During the workshop, 15 speakers and 112 participants addressed the subject of ungulate carrying capacity and the effects of fires, new winter range, and the proposed reintroduction of wolves.

Participants in the workshop reported the following conclusions regarding the events of the 1980s:

New Winter Range

Several speakers concluded that the increased migrations of elk north of the park boundary since about 1978 combined with mild winters probably explained the increases in both elk and bison numbers during the decade of the 1980s. New winter range acquisitions since 1988 (Fig. 1) have received high use by elk, particularly on the new Dome Mountain Wildlife Management Area in Montana (Fig. 1). Mike Coughenour (Colorado State University) and Francis Singer (NPS) reported progress on a nutritionally based model of elk carrying capacity to predict the effects of the winter range acquisitions (and the fires of 1988).

The Fires of 1988

The large fires of 1988 are predicted to result in elk population increases – some researchers predict a large increase, others, a minor one. Monica Turner (Oak Ridge National Laboratory) and others reported on the progress of model effort to predict the effects of fire size and spatial heterogeneity on ungulate survival. The Coughenour model will predict the changes in elk population size from the fires of 1988.

Human Activities

Mary Meagher (NPS) reported the carrying capacity of bison winter ranges has been enhanced by the grooming of interior park roads. Bison move more easily to distant parts of the winter ranges on the groomed roads.

Proposed Reintroduction of Wolves

If wolves were reintroduced to Yellowstone, E.O. Garton and others (University of Idaho) predicted 75 wolves in about 9 packs would inhabit the park's northern winter range. These authors predicted the northern elk would decline no more than 10 percent after wolf reoccupation (Fig. 3). They predicted negligible effects on elk harvests.

Mark Boyce (University of Wyoming) predicted a moderately high probability of wolf extinction if fewer than 10 wolves were reintroduced. He recommended a seed of 30 wolves. His models predicted 15 to 25 percent fewer elk and 5 to 15 percent fewer bison on the northern range after complete wolf recovery. Variance in ungulate numbers due to climatic variations should decrease; 15 to 25 wolves might leave the park each year.

David Vales and James Peek (University of Idaho) predicted slightly lower total elk harvest after wolf recovery in the Gallatin and Sand Creek elk herds. Hunter harvest must be directed primarily at bulls in heavily harvested elk herds.

Francis Singer (NPS) predicted Yellowstone Park could support the territories of 8 to 11 wolf packs and portions of the territories of another 3 to 4 packs. Wolves were predicted to kill ungulates in the order: elk > bison > mule deer > moose > pronghorns > bighorns. Wolves should have only minor impacts on ungulate distributions. Mostly adult female ungulates with very young have been observed to alter their habits when wolves are present. Coyotes are predicted to decline and red foxes to increase after wolf recovery. Visitors would see about as many ungulates after wolf recovery. Visitors would be minimally affected by some closures of a few square miles near active wolf dens from about April 1 to June 15.

Researchers utilized a wide variety of predictive techniques. To those, Merrill/Boyce added summer grassland phytomass. Predator-prey models were then constructed from knowledge from the literature of wolf densities, wolf predation rates, wolf consumption rates, and known or simulated functional and numeri-

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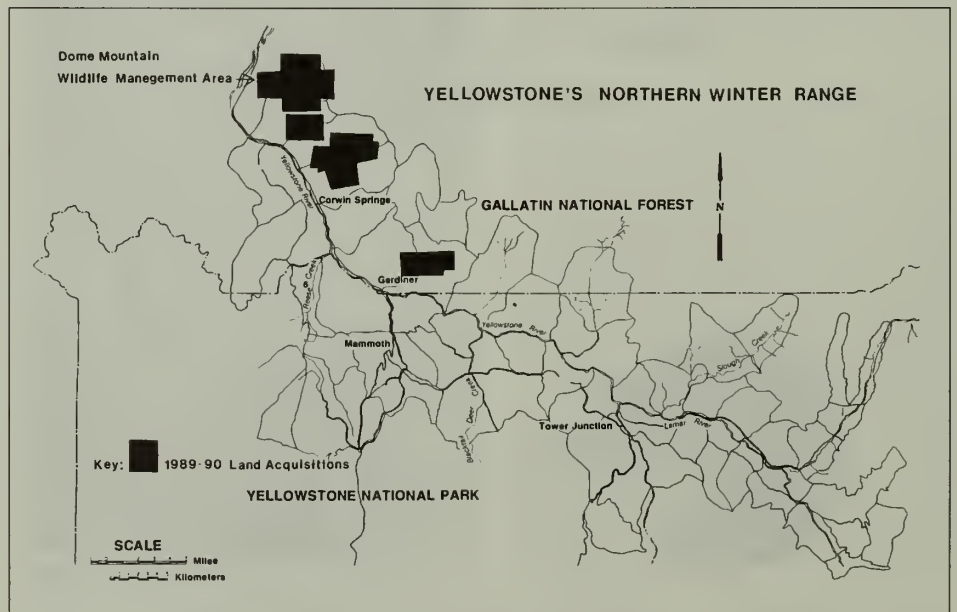


Figure 1. Winter range acquisitions north of Yellowstone National Park, 1989-90.

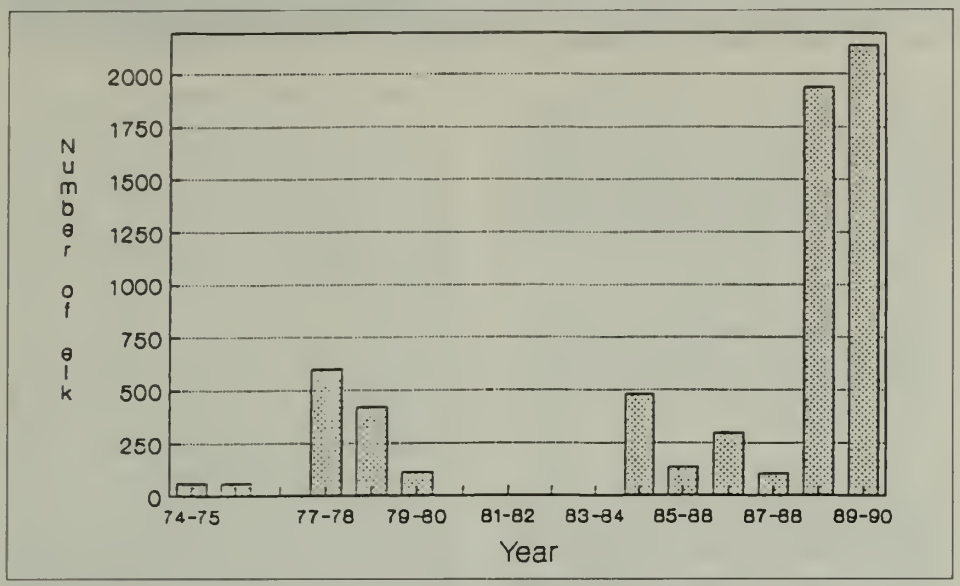


Figure 2. Maximum number of elk counted during the winter on the Dome Mountain-Stands Basin area from 1974-75 to 1989-90. Data from Chrest and Herbert (1980), Chrest and Peterson (1979), and NPS files. Missing bars indicate no data were obtained.

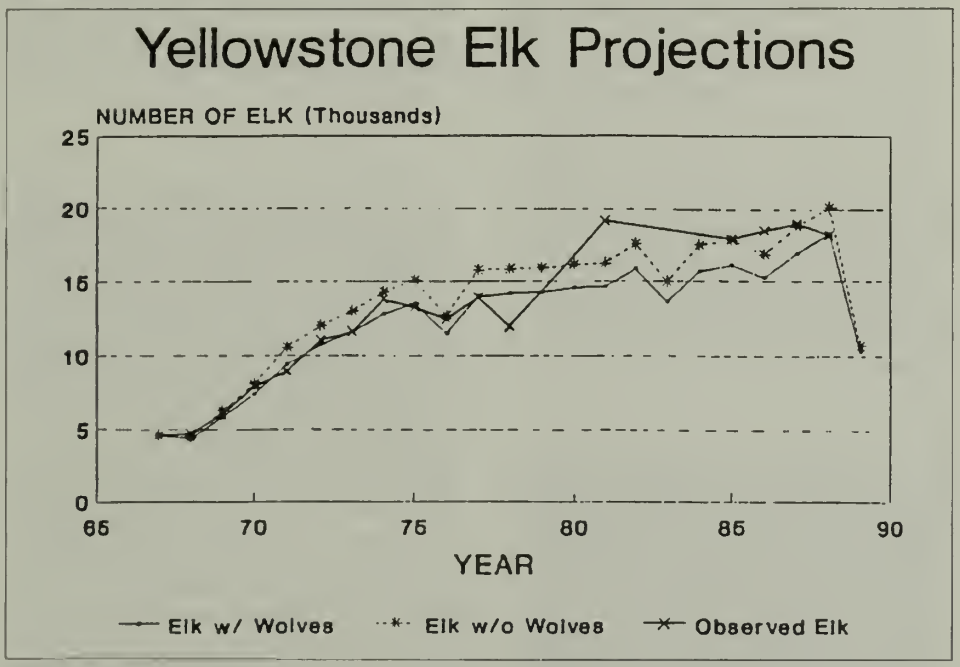


Figure 3. Slightly fewer elk are predicted for the northern Yellowstone elk herd in the presence of wolves (figure courtesy of E.O. Garten).

cal responses. Garton's model varied from the Boyce model principally in that wolf predation was apportioned by wolf social class. Vales and Peek utilized Leslie matrix and balance models. Singer, Servheen and Knight (not present) based their predictions on literature reviews, interviews and correspondence, while Koth and others (not present) used the Delphi survey method. Larry Roop (Wyoming Game and Fish) reported on the use of Pop-II models to predict effects of hunter harvests on ungulates, and Tom Hobbs (Colorado Division of Wildlife) described the interface between population and plant-based models of carrying capacity.

Conclusions

A concensus was reached that the mild winters of the 1980s were primarily responsible for recent increases in ungulate numbers. Both the fires of 1988 and purchases of the new winter ranges will result in larger numbers of elk, but winter severity will continue to have a strong influence on elk numbers. Managers and interpreters should be prepared for the elk increases. Researchers concluded that the presence of wolves would result in <10 percent to <25 percent fewer elk and 5 to 15 percent fewer bison. The workshop participants recommended that more information be gathered over the next few years on ungulate response to the large fires of 1988. A period of accelerated data collection on ungulates and other predators should precede any wolf reintroduction.

Singer is a Research Ecologist at Yellowstone NP.

Suggested Reading

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Bark Beetle Battle Given Historic Treatment

A fascinating historical account of the combined efforts of three government agencies to eradicate the mountain pine beetle (*Dendroctonus ponderosae*) in one particular area is contained in the recent publication, ***The Battle Against Bark Beetles in Crater Lake National Park: 1924-34,*** by Boyd E. Wickman, research entomologist with the USFS Forestry and Range Sciences Lab in LaGrande, OR.

The report records the first large-scale bark beetle control project in a national park in the Pacific Northwest. It describes the relations among NPS, USFS, and USDA Bureau of Entomology personnel, how the project was organized, the ecological implications of the outbreak, and the long-term results of direct control measures.

Long-range historical light is shed on the activities of the first year (1925) – the insect situation, the main human characters involved, the recommendations from all participants in the decision-making, and the treatments administered. The 8-year "war" that ensued is covered in detail, with historical photos, memos and correspondence from old files, even cartoons of the time.

Wickman, in a section titled "The Aftermath," concedes that "hindsight is often 20/20, but it is hard not to give the beetles credit for defeating the puny efforts of the entomologists to stop the infestation." He points out that most of the lodgepole pine stands in the area of infestation were at a susceptible age for attack and that control efforts were of little avail.

"The main lesson learned," Wickman writes, " was that once a mountain pine beetle population erupts over a large area of susceptible forest type, and as long as environmental conditions remain favorable, there really is no way to stop it until almost all the susceptible trees are either killed or removed by logging."

In 1984, lodgepole pine stands in central Oregon were once again ravaged by the mountain pine beetle, Wickman notes, and by 1985 a severe outbreak covered thousands of acres and extended south nearly to the park boundary. "In 1986, beetle-killed trees were found in the northern end of the park," he writes. "We found groups of lodgepole pine being attacked by the mountain pine beetle, so we have come full circle with a new outbreak in progress."

As an epilogue, Wickman tacks on a ditty by an anonymous author that was published in 1925 in a Western Division newsletter, ***Forest Insect Investigations,*** put out by the Bureau of Entomology, Stanford University. In part, it goes like this:

The Song of a Park Ranger

The bugs, they're killing the timber
They've worked for many a year,
But the entomologists prophesy
That they'll quickly disappear.
Chorus:
Oh! they ain't gwine fly no more, no more,
They ain't gwine fly no more;
But how in the ---- can the bug men tell
They ain't gwine fly no more.

For the rest of the song, see the PNW-GTR-259, available from USDA Pacific Northwest Research Station, 319 S.W. Pine St., PO Box 3890, Portland, OR 97208.

information crossfile

If you have trouble "pushing things back an additional 10 million years," don't bother reading the rest of this.

A 135-million-year-old fossil found in China appears to be that of the oldest bird yet known that lived in trees and flew with agility. This is according to researcher Paul Sereno, who came up with his own entry into the "oldest known bird" sweepstakes at the October 12 (1990) meeting of the Society of Vertebrate Paleontology in Lawrence, KS. The specimen was found in 1987 in northeastern China and the Beijing Natural History Museum asked Sereno for help in studying it.

The most recent fossil find, not yet officially named, evidently followed by about 10 million years the Archaeopteryx – a ground-dwelling, toothed precursor of modern day birds that could climb trees, jump, and flap its wings but probably was unable to engage in long range flight or to live in trees.

A truly tree-dwelling bird fossil was found two years ago in Spain, dating back 125 million years, but this new report "pushes things back an additional 10 million years." The sparrow-sized bird retained some dinosaur characteristics: moveable fingers on the front edge of its wings, a lack of fusion of many of its bones, and a club-shaped end of the pubic bone that may have rested on the ground when the bird sat. But according to John Ostrom, curator of vertebrate paleontology at Yale Peabody Museum of Natural History, "it was very definitely an advanced-level bird" and showed that modern-day flying ability came about very early in the history of birds, he said.

⁂

The ***New York Times News Service*** reported in early October that "a gaping hole in Earth's protective ozone layer has again opened over Antarctica, and scientists reported on October 12 that the depletion of ozone there seemed to be nearly as severe as it was in the worst previous years, 1987 and 1989." NOAA and NASA agreed that this is the first time a severe Antarctic ozone hole has developed in two successive years, implying increasing health hazards throughout the world.

Dr. Mark Schoeberl of NASA's Goddard Space Flight Center said the minimum value of the ozone shield over Antarctica this year fell to 124 Dobson units on October 4. Dobson units are a measure of the ability of the atmosphere to absorb certain wavelengths of light, including a dangerous form of ultraviolet radiation. When the ozone layer was intact, normal readings above Antarctica reached 500 Dobson units. When chlorofluorocarbons reach the stratosphere they break apart and destroy ozone, prompting fears of an epidemic of skin cancer and cataracts for humans and damage to crops, notably soybeans.

⁂

Coral reefs around the world are suddenly starving and in many cases dying, the ***LA Times-Washington Post Service*** reported in October 1990, "because of abnormally warm seas. The news service quotes leading marine scientists as seeing this phenomenon as an early warning system for environmental degradation.

The coral reef die-off occurred three times in the 1980s and may be more serious this year (1990), biologists contend. Locales where coral reefs are "blotchy and sickly" include athe Florida Keys, Puerto Rico, Jamaica, the Bahamas, Bermuda, Hawaii, and Okinawa, and most researchers suspect higher sea temperatures as the culprit. As water heats up, the coral polyps that build the reef with their skeletal remains spit out the microscopic algae that help feed the coral and give the reef its golden, red, and yellow hues. The phenomenon is called "bleaching." Without its algal partner, the coral becomes weak and stops reproducing. After several weeks, it may die.

Robert Wicklund of the NOAA Caribbean Marine Research Center sees the reefs as "in peril and disappearing at an alarming rate." Corals in past episodes would often return to health, but there is preliminary evidence, he said, that repeated stress may make recovery more difficult.

⁂

The Navajo Generating Station at Page, AZ, has "contributed significantly" to a haze that periodically dims the vivid colors of the Grand Canyon, according to a committee of the National Academy of Sciences. The findings were reported in October by ***Cox News Service.***

The committee added that other power plants, ore smelters, and the exhaust of distant automobiles also contribute to the problem, so that even if the best available pollution control devices were installed on the Navajo plant, the Grand Canyon's wintertime haze "would most likely be reduced, but not eliminated."

Owners of the power plant hailed the academy report as evidence of "flaws" in a 1987 NPS study, which indicated that during the winter, climate conditions favored bringing sulfurous emissions from the plant to the rim of the canyon 65 miles away, and that haze could be traced at least partly to the plant.

The NPS experiment triggered an EPA regulatory proceeding that could require the Navajo station to install up to $1 billion worth of pollution control equipment.

Another unlikely source for an Information Crossfile item was James J. Kilpatrick, whose mid-October column on language uses and misuses contained this gem:

"***The New York Times*** reported last year that a nature conservancy near Palm Desert, Calif., is doing well. It protects lizards, burrowing owls and 'raptures of all kinds.' A lovely thought, to preserve a rapture, but the sanctuary probably is preserving raptors."

Helen Lorber of the ***Knight-Ridder News Service,*** in reviewing Jean Auel's latest book in the "Earth Children" series (starring Ayla, who seems personally to have made every advance in prehistoric human history), makes one observation that deserves a place in these pages. Lorber objects to "the excrutiating detail" in which Auel describes "the weather, flora, and fauna." She offers as an example, the following paragraph:

"Relict areas of temperate deciduous trees were maintained in certain protected areas and at the lower latitudes, with hardier needled evergreens appearing in the boreal regions to the north of them"

Lorber continues, "A certain amount of factual material is important, but Auel seems intent on including every fact she dredged up in her research." (A major source for Auel's "excrutiating detail" was a paper on Paleoecology of Beringia. No citation given.)

Three authors, Robin Lambert Graham, Monica G. Turner, and Virginia H. Dale, explore the dramatic and exceedingly complex changes likely to occur in the forests of the world as a consequence of elevated CO2 and climate changes. In an article in the September 1990 issue of ***BioScience*** (40:8, pp 575-587), they look at the ways forests directly affect climate at the global scale (by altering the earth's albedo, hydrological regimes, and atmospheric CO2) and at a local scale (by altering temperature, humidity, and solar radiation). They also examine forest *responses* at many scales. They use, as a framework, four levels of biotic organization – the biosphere, the biome, the ecosystem, and the tree, taking into consideration forest responses that cross these scales.

The article, which also is available as Publication #3476, Environmental Sciences Division, Oak Ridge National Laboratory, examines the potential forest responses to elevated CO2 in conjunction with climate change. For each level of biotic organization (illustrated with excellent graphics), the authors discuss the potential effects on key ecological processes, how human intervention can affect those processes, and the role of modeling in elucidating and predicting forest responses. The article concludes with a discussion of future research needs.

⁂

In the same issue of ***BioScience*** (pp 558-562), Anna Maria Gillis describes an ecosystem approach to land management in a feature article entitled "The New Forestry." She considers the Jerry Franklin approach (called "new forestry"), with its claims that commodity production and preservation of ecological values are not completely incompatible, and looks at the field of response to this idea, from both proponents and critics. The consensus, she concludes, is that "much research still is needed."

A sidebar story describes the report, ***Forestry Research: A Mandate for Change,*** released in July by the National Research Council Committee on Forestry Research. The report calls for more research in five areas, one of the goals of which "should be creation of forest management systems that produce commodities while maintaining ecological values." The committee was paraticularly concerned that "the forest science community does not now have the human resources to do the research our nation requires."

⁂

A syndicated feature by Steve Newman entitled ***Earthweek: A Diary of the Planet,*** which appeared in mid-October 1990, describes how Italian officials plan to force members of the Mafia out of their remote mountainous refuge at the southeastern tip of the country and turn it into what could be the largest national park in Europe.

"Aspromonte, where caves are now used to imprison victims of the Mafia's 'protectionist racket,' would become a peaceful retreat," according to Newman. "Vacationers could wander on nature trails or explore natural science in new museums. Theoretically, 27,000 national forest guards patrol the area, but the 'Ndrangheta,' or Calabrian branch of the Mafia, is the force that controls it, and puts out forest fires. Their expulsion from the wilderness would mean the end of an era in which the efficiency of organized crime preserved nature against man-made destruction."

information crossfile

Fisheries and Coastal Wetlands Research, Volume 6 of the Proceedings of the Conference on Science in the National Parks, 1986, saw the light of publication just before the 1990 Conference convened in El Paso in November 1990. The 184 page document, edited by Gary Larson and Michael Soukup, is available through the George Wright Society, PO Box 65, Hancock, MI 49930-0065.

⁂

"Bats are integral components of all ecosystems. Everywhere you find them, they're very important to the area." Thus speaks Jacqueline Belwood of Bat Conservation International, quoted in an October 25, 1990 ***Oregonian*** feature section devoted to bats. The only mammal capable of powered flight and with 920 species worldwide, they form the second largest mammal order – exceeded only by rodents. They exist on almost every continent, and in nearly every country, and they eat about half their weight in insects every night. The flowers of the agave plant (source of tequila) become reproductively active only at night. Without bats, the plant's seed-set drops to 1/3000th of normal. In some areas, a decline in vegetation, infestations of harmful insects, and even climate changes are thought to be the result of diminished bat populations.

⁂

A strong correlation between Pacific weather conditions and the spread of fires months later in Arizona and New Mexico has been reported by two scientists, Thomas W. Swetnam (U/AZ) and Julio L. Betancourt of the USGS. R. Monastersky reports on their findings in Vol. 138 of ***Science News*** (p. 132). The Tucson-based scientists sifted through fire statistics back to 1905 for national forests in the Southwest and compared them with wintertime fluctuations in the Southern Oscillation – a record of air pressure over the central Pacific that can serve as an indicator for El Nino (ocean surface water warming in the central Pacific) and La Nina (when surface water in the central Pacific turns unusually cold for a year or more.)

The most extensive forest fires in the southwest have struck predominantly during La Nina; relatively minor southwestern fires have developed during El Nino periods.

While the correlation is not perfect, a chart superimposing the Southern Oscillation on a record of areas burned leaves little doubt as to a relationship – one that Swetnam says can prove useful for officials planning prescribed burns. "If we have a La Nina situation in winter months," he asserts, "I would say caution is advisable.

With the hope that there is no gruesome coincidence in the fact, we report here that Halloween 1990 was the 61st anniversary of the Archeological Protection Act. May it escape all hobgoblins and enjoy many many happy returns!

Most oil spill cleanup efforts are doomed to failure, and even major oil spills produce environmental and scioeconomic consequences that are "relatively modest and, as far as can be determined, of relatively short duration."

This is the conclusion of James Mielke, author of ***Oil in the Ocean: The short- and long-term impacts of a spill,*** 90-356 SPR, available from CRS, Library of Congress, as reported on page 371 of the October 19, 1990 issue of ***Science.***

Researchers contacted by ***Science*** tended to agree with Mielke's assessment, but added the proviso that oil stuck in quiet coves and marshes can persist at toxic levels longer than in areas exposed to wind and wave. Still, they say, recovery begins in years, not decades.

⁂

NAPAP (the National Acid Precipitation Assessmen Program) became history on October 1, 1990. The 10-year, $535 million study of acid rain thudded to a 3-volume conclusion that acidic pollutants have changed the landscape in certain especially vulnerable regions, and predicts where and when future benefits might accrue from tightened controls on fossil-fuel emissions.

Science News (September 15, 1990, p. 165) quotes a Natural Resources Defense Council spokesperson (Deborah A. Sheiman):

"We knew in 1980 what they're telling us now: What causes acid rain, how to control it, what are the effects." By "studying the problem to death" she charged, NAPAP "became a convenient excuse for political inaction."

Christopher Bernabo, NAPAP's first director and now a Washington DC consultant disagrees. He thinks NAPAP's most lasting legacy will prove to be organizational. The focus required for the program, he says, not only taught government agencies how to collaborate effectively but also showed them how "to make the transition from curiosity-driven research to policy-making research."

The September/October 1990 issue of ***National Parks*** magazine describes in historical detail how the U.S. Army Corps of Engineers is beginning to "undo its own damage" to the Florida ecosystem. The drainage system built by the Corps – some 1,500 miles of canals and levees, left Florida with a legacy of polluted and declining water supplies and a dying ecosystem in Everglades NP. "Now," says author Vicki Monks, "having spent hundreds of millions to drain the Everglades, the Corps has enthusiastically agreed to spend hundreds of millions more to undo some of the damage."

Concern now is focused on the specific designs for restoration of natural water flows in the Shark River Slough and the Taylor Slough, the two main sources of water for the park, Monks writes. "Last year, Congress approved legislation expanding the park by 107,000 acres to include all the Shark River Slough. The Corps was directed to re-engineer the water supply to provide some close approximation of natural patterns."

Chief of Engineers General Henry Hatch is quoted as follows:

"Embracing and promoting our environmental ethic will change the way we do our traditional business," and he further pledges the agency to strive toward becoming "the environmental engineers of the future."

⁂

In ***Science News,*** September 22, 1990, Richard Monastersky reports on two paleontologists – William A. DiMichele and Scott L. Wing – who are working in the recesses of the Smithsonian Museum of Natural History on ancient swamp research. How did life survive 315 million years ago in the face of climate changes (DiMichele's study area) and again at about 55 million years ago (Wing's study focus.)

The article describes their findings in some detail, and then comes up with what Monastersky calls "an unsettling message regarding the threat of a global warming." If the planet warms as many scientists predict, temperature and rainfall patterns could shift faster than ever before, placing unprecedented levels of stress on the environment. This is the crux of what the researchers think they have discerned in their "tales from the swamps" of the past.

"If biological communities have a certain threshold for climate change, as DiMichele and Wing suggest," writes Monastersky, "ecosystems such as the boreal forests might show no signs of weakness until stress crosses that threshold and the communities abruptly collapse."

⁂

"After more than two decades of silence, the cliffs of the Columbia River Gorge are again echoing the shrieks of the peregrine falcon."

Thus opens a story titled "Back in the Nest," by Eric Goranson of the Portland ***Oregonian*** staff, as it appeared in the October 18, 1990 issue of the newspaper.

"Reduced to only 27 known pairs of birds nationally in 1975," Goranson reports, "and with no known wild breeding pairs in Oregon as recently as 1985, the falcon is being considered for removal from the endangered list in some areas of the country. Today the U.S. count is estimated to be 1,500."

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Redwood NP Geologist Reports On Gravel Bed Rivers Workshop in Italy

Editor's Note: In September (23-28) 1990, Mary Ann Madej, Redwood NP geologist, and Thomas Lisle of the USFS presented an invited talk on "Spatial variation in armoring in a channel with high sediment supply" at a fall workshop held in Florence, Italy. Following is Madej's report on the conference, which she attended on an award from the Horace M. Albright Employee Development Fund. The paper she gave will be published by John Wiley and Sons in a book entitled ***Gravel Bed Rivers.***

By Mary Ann Madej

Environmental consequences of natural and anthropogenic changes in rivers have become areas of national and international concern. The Third International Workshop on Gravel Bed Rivers was held Sept. 24-28, 1990, in Florence, Italy to address river management problems and their underlying causes. The theme was "Dynamics of Gravel Bed Rivers"; 92 participants from 17 countries, including New Zealand, Japan, Switzerland, Israel, Germany, Iran, Somalia, and Czechoslovakia attended.

The 47 papers were distributed beforehand, and after two or three short presentations at each session, an hour-long discussion period allowed workshop participants to thoroughly debate controversial issues. Video sessions provided vivid illustrations of problems and studies in other countries. Discussion comments will be published with the conference papers.

Italy made a fascinating setting for the meeting, particularly for a scientist used to augmenting short-term records with sometimes ambiguous field evidence. I was startled to read accurate accounts of flooding from November *1333* (when the Arno River floodwaters overtopped the altar in the Duomo in Florence), and to see a landscape that has been cultivated intensively for at least 2000 years.

Post-conference field trips to research sites further enforced the urgency to deal with erosion and sedimentation in order to preserve natural and cultural resources. For example, soil loss from vineyards north of Florence was measured at 2.33 mm/yr (equivalent to 9 inches of soil erosion in 100 years). Such high erosion rates surely will influence long-term soil productivity, stream sedimentation rates, and the economic viability of a region.

Large sand bed rivers such as the Mississippi have been studied for centuries, but less attention has been focused on gravel bed rivers, which differ from sand bed rivers in several ways. Gravel bed rivers have riffle/pool bedforms rather than ripples and dunes. Sediment moves only at moderately high to high flows, and sediment transport dynamics are different. Gravel bed rivers tend to be steeper, are located in more rugged terrain, and are more stable in channel cross-sectional shape. Over the last decade interest in gravel bed rivers has grown, due to increasing pressures on upland areas in both developed and developing nations.

Rivers are critical for maintaining riparian and aquatic ecosystems and for influencing land management activities. They are used for recreation (swimming, boating, fishing, hunting, hiking, birding), navigation, water supply, power generation, sand and gravel supply, wildlife corridors, and flood routing. Human activities such as road construction, flood control, logging, and urban development have caused reservoir siltation, sedimentation in navigation lanes, bank erosion, water quality degradation, water depletion, pollution by toxic wastes, and modifications in flooding frequency.

Concomitantly, development is encroaching on many areas that are susceptible to erosion and sedimentation problems, such as landslide prone sites. Catastrophic dam bursts, debris torrents, and floods also have highlighted the need for studies of gravel bed rivers.

River research (fluvial geomorphology) is basically a study of the nature of change through time and space. Discussions focused first on the nature of environmental change. How do we separate natural versus artificial change? Do we act now or later to reverse change? To what extent and at what scale do we act? How can we restore or conserve resources? As we try to understand implications of global climatic change, our knowledge of watershed responses to past climatic changes will help answer these questions and guide policy decisions.

Specific field studies came next. Erosion models and case studies of sediment yield incorporated remote sensing, GIS, and field documentation to evaluate short- and long-term soil loss from forested, logged, and cultivated areas. Steepland processes discussed during the conference included debris flow initiation and deposition, alluvial fan formation, and floodwaters with extremely high sediment loads generated from mountainous areas. Debris torrents can devastate highways, railroads, buildings, and vegetation. Several presentations stressed the necessity of interpreting debris flow deposits in order to understand debris flow mechanics and help predict future damage.

Many papers discussed the transport of sand and gravel in braided and meandering rivers. Research concerns included quantifying when sediment is moved, how far it moves, and what size and shape particles move. Painted rocks, magnetic tracers, and even radio transmitters have been used to track gravel movement. In some gravel bed rivers the dominant size of transported sediment is actually sand. Innovative techniques to measure bedload and new statistical analyses were presented. Gravel size distribution influences salmonid spawning success. An input of fine-grained silts and sands can either penetrate spawning gravels or form a seal on streambeds, to the detriment of aquatic life. Streambeds consolidate (or become more compacted) through time, and this may affect spawning success as well.

Coarse gravel layers frequently form over finer streambed material (an armor layer). This layer may protect underlying streambed sediment from erosion until flows become quite high. How this armor forms, its spatial variability, and its importance in controlling bed mobility were explored. Bed mobility also influences the survival of salmonid eggs and juveniles. In Redwood Creek in north coastal California, severe erosion and sedimentation caused widespread channel instability in the past, threatening old growth redwood trees along the river and salmon population. Dr. Thomas Lisle of the USFS and I presented results of studies in Redwood NP, assessing channel stability, bed mobility, and armoring.

Channel stability affects both natural and cultural resource. Causes of bank erosion were debated. New solutions to bank erosion problems (besides unsightly and locally damaging riprap) were presented. Gravel mining can initiate channel instability (bank erosion, channel shifting, and channel downcutting). Erosion control structures have been used to stabilize river channels in Europe since the 1850s. The lessons learned from their successes and failures can help guide our decisions on the use of modern structures.

Long-term changes in river systems were explored. The record of flooding history can be extended through interpretation of floodplain sediments. Some upland rivers show significant channel pattern change, whereas others under similar geologic and landuse conditions remain stable. The main factors influencing channel change are landuse and climate; however, streambanks may erode and meandering bends may



***Old-growth redwood trees** along Redwood Creek in Redwood National Park.*

Technical Writing As a Tool – An Art

Editor's Note: In the spirit of celebration of ***Park Science****'s 10th anniversary, this article by Jim Wood is reprinted. When it first appeared, in the Spring 1983 issue, my Editor's Note was a single word:* Amen! *I echo that sentiment as we reprint this excellent and instructive piece. At the same time we mourn Jim's recent resignation from the NPS (where he has for years been the technical editor, working out of the Southeast Region) in order to accept a job with the USFWS in Atlanta. He will be sorely missed!*

By Jim Wood

The need for high quality in research papers has never been more evident than in today's fast-paced, complex technological age. Our minds boggle from the accelerating expansion of research and all the publications resulting from it. The practicing scientist, manager, or administrator has only limited time to keep abreast of the voluminous literature. His problems multiply and intensify when that literature is verbose, vague, and boring. He deserves to read articles that are technically sound, informative, well-organized, and a pleasure to read. He must be able to grasp information and ideas at a single reading, without having to reread sentences or puzzle over ambiguities.

Although I believe the writing of many NPS scientists is of high quality, as an editor I have seen no manuscripts that could not be polished and improved. Some have been prepared so poorly and in such careless, sloppy language that they fell far short of the high standards on which the Service must insist. It was impossible to judge their scientific worth until they were translated into reasonably acceptable English.

Some of the best (and some of the poorest) written English I have seen is the work of technical men and women – biologists, geologists, social scientists. Technical writers, whether they realize it or not, start with an advantage. Their basic material is concrete facts and events. Their main object is to describe such and show the relationships between them.

In my judgment, the best technical writing is being done by persons at the top of their professions. They have done important work, understand its meaning, and write about it with confidence. They are bold and sure enough to write simple, direct English.

Too many others, who lack experience and assurance, tend to write with an uneasiness that leads to fog. They smother their meaning in qualification and jargon. Still others are so engrossed in their work that its "special language" has become second nature to them. They overlook how awkward and puzzling this gobbledygook can become when allowed to clot on paper.

The scientist who is sure of him/herself includes, of course, qualification and specialized technical terms when required. But s/he also recognizes the surplus that can be safely shed. This is an important part of wisdom and essential to clear communication.

I find it ironic that:

(a) Most scientists do very well in oral communication, talk simply and clearly, and can explain to a layman what they are doing. But once they begin to write, they shun simple English and slip into an odd jargon they consider "traditional" and "safe." They are afraid that if they did otherwise, their writing might seem "unprofessional." It is *never* unprofessional in the sciences to make oneself clear!

(b) Although many technical and professional people are poor writers, they read no better and are no less confused by fog than laymen. This is easy to judge from the lively oral discussions often printed following the scientific papers of technical meetings. Many scientists habitually skim the articles, and then read closely the oral discussions!

All the foregoing doesn't mean scientists should write their reports for grade-schoolers. Neither should they write their papers as "all things to all people." What I want to emphasize is – *any piece of writing should revolve around the intended reader.* The report should be related to the reader's experience. It should prepare him for what he is about to read. It should be presented in a rational, logical manner and enable him to gain facts and their relationships in the shortest possible time.

Any scientist who writes a paper has spent time gathering facts and contemplating their meaning. The interpretation of meaning is usually the most important part of the paper. The author owes it to the reader to make clear the meaning he has been able to draw from the facts – *without* neglecting to underline points that are still unclear or unsolved. This is especially important for scientists working for public land management agencies like the National Park Service. They have a clear obligation to park managers charged with the stewardship of these lands.

When a scientist writes for those outside his field he should take care to avoid or explain technical terms that are not commonly familiar. In writing for people within his own field, he should review his technical writing self-critically and ask himself: Am I using these words to express or to impress? Am I using them because they are necessary to make my ideas clear, or am I using them merely to signal that I am an expert?

Four guidelines will help:

(1) Arrange the material logically. Organize your writing in logical order. Don't begin your report in unknown specifics rather than familiar basics. Most audiences regretably are still more familiar with yards and acres than with meters and hectares. If you need to use both systems, ordinarily you give the familiar one first, then use parentheses to convert to the other system. *(Ed.'s note: This no longer applies to* ***Park Science*** *articles. Our readers are comfortable with the metric system.)*

(2) Prefer the active voice. Technical writers should make a special effort to avoid a monotonous series of passive constructions. Active ones are shorter and more readable. Example:

PASSIVE: The melting point of the alloy was lowered 50Th)Tdegrees by adding 10 percent of aluminum.

ACTIVE: Adding 10 percent of aluminum lowered the melting point 50 degrees.

(3) Don't make nouns out of good, strong "working verbs." Making nouns out of verbs tends to smother the meaning of sentences. Example:

SMOTHERED: Authorization must be received from the Research Director before utilization of new methods can be incorporated in this project.

IMPROVED: The Research Director must authorize new methods before they are used in this project.

(Why not "utilize"? Isn't that the verb form of "utilization"? Yes, it is. But "use" is shorter, crisper, and less stuffy.)

The main trouble with smothered verbs is this: Anytime you change a working verb to a noun, you must add another verb to complete the sentence. Also, you can see from the above example that smothered verbs and passive constructions frequently go together. In fact, they are almost inseparable. If you can "unsmother" a verb, and at the same time change a passive to an active construction, you'll cut sentence length by a third and increase the chance for interest and understanding.

(4) Be concise – cut out excess baggage. Technical writers should strive to eliminate unnecessary complexity by reducing sentence length. Example:

ORIGINAL: Comparison of data obtained with these paints using Barco with those using Lenol revealed that use of Barco solvent slowed the drying appreciably (approximately doubling the time in most instances) but had very little effect on the viscosity characteristics obtained.

REVISION: The data showed paints using Barco were no more viscous than those using Lenol, but dried only about half as fast.

These guidelines do not cover every possible "poor writing" situation – just a few of the more common ones. For those who wish to learn more, I suggest this paperback: ***Writing with Precision*** by Jefferson D. Bates; published by Acropolis Books, Ltd., Washington, DC 20009; $6.95.

In these days, more than ever before, the reading time of a scientist is precious. Few of them like the task of writing. But writing is the chief means (and permanent record) of handing on what they have learned.

Remember, write for the reader, not for the filing cabinet! And most of all, write to *inform* – not to prove that you're smarter than your readers!

Continued from page 12

evolve naturally through time, even without climatic or landuse changes.

In concluding remarks, Dr. Luna Leopold, (son of Aldo Leopold), cautioned us to keep our sights wide. As we focus narrowly on individual problems, he urged us to keep in mind the broad questions of river dynamics, climatic change, and landscape evolution.

Several problems of direct concern to Redwood NP received conference treatment. For example, gravel mining and bank erosion locally threaten park resources. Channel stability is important to the survival of Redwood Creek aquatic life and old growth redwood trees. Changes in bank erosion rates and locations or in gravel transport patterns can be detrimental to these resources. A highway construction project located in a headwater stream adjacent to Redwood NP delivered a large amount of fine-grained silts and sands to pristine reaches of the park farther downstream. Monitoring techniques presented at the conference gave me insights on how better to measure the impacts and persistence of fine-grained sediment on aquatic life and stream dynamics.

Several of the new erosion and sediment modeling techniques and analyses described will be incorporated into the Redood NP monitoring program. Our flood history project will benefit from new approaches to floodplain sediment analysis. I became convinced of the importance of incorporating climatic change monitoring into process studies in park watersheds.

Finally, it is important to note the social and economic implications of attending such a smeeting. Europe is no longer a step behind the U.S. in river studies. Many papers made it clear that Europe, Japan, and New Zealand are devoting the money and energy needed to solve river management problems. Formation of a unified European Community in 1992 will affect science and resource management, through side-ranging government policies and a free exchange of scientists. U.S. scientists must stay abreast of international advances to maximize our efforts.

Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report

By Seth Tuler and Chuck Janda

Mountain goats were first introduced to the Olympic Peninsula by sport hunters in the 1920s. In the 1970s, studies by the NPS and the University of Washington found that the original 11 or 12 had increased to one of the highest density populations in North America. In 1983 the park counted an estimated 1200 goats on Olympic Peninsula; about 1000 were in the park.

Disturbances from these exotic animals have been documented for portions of the unique ecology of Olympic NP (***Olympic National Park*** 1987). They include erosion problems created by wallows, trails, and dusting, disturbance of endemic and preferred forage species, and alteration of the structure and productivity of alpine and subalpine ecosystems. As goat populations and human interest have grown, potentially hazardous encounters between salt hungry goats and curious visitors also have grown. (***Park Science,*** Fall 1981, p.5).

To prevent further damage to the senstive high country, Olympic NP began an experimental program to rid the park of mountain goats in the early 1980s. Various techniques were tried, ranging from backcountry operations to sterilizing goats to the capture of goats in drop nets and foot snares. In 1988, after a 10-year review process, Olympic NP began a live-capture and removal program, requiring innovative and difficult activities in some of the park's most remote and rugged backcountry.

In brief, a pilot and "gunner" perform high risk helicopter flights to identify, select, pursue, and capture goats. After goats are darted or netted, the gunner must alight from the helicopter, restrain ("bag"), and secure the goat to the helicopter. The animal is then flown to a staging area at Hurricane Ridge and transferred to another agency (such as the Washington Dept. of Wildlife) for release into native populations elsewhere. (The sequence begins with preparations of personnel and equipment, and proceeds to "fly-out," search and selection, capture and restraint, medical assessment and preparation, goat transport, crew recovery, flight-in, demobilization, and postcapture tasks.)

Multiple goat captures may occur during one day's activities. In 1989 the average number of captures per day was six. Successful completion depends on effective, safe, and reliable human and equipment performance at all times.

The program has been performed with high degrees of safety for project personnel despite the many risks they face. Ranger Rich Olsen has been instrumental in the design of special project activities and development of unique equipment and protocols. However, the numbers of goats captured have been smaller each year. In 1988, 80 goats were captured; in 1989, only 67. Some of the goats die from stress induced complications or bones broken during capture. In 1988 the mortality rate was 9 percent; in 1989, it was 19 percent. Risks to both personnel and goats have risen over time. "The general impression was that the goats were in less accessible areas of the park, they were harder to get to, and we were forced to take greater risks with the animals and staff in orde4r to get them." (Chief Ranger Chuck Janda, from ***Animals,*** p. 24). As a result of the concern for both personnel and goats, critical reviews have been done in June and July each year prior to the next season of live capture.

Systems that push the bounds of human and mechanical capabilities are also pushing the luck of those involved.

Here, we summarize the results and implications of two program reviews completed in spring 1990. The first, a report on the social factors that contribute to risks, was prepared by the NPS/CPSU at U/ID. We also describe the results of a review by the Interior Department's Office of Aircraft Safety.

A Social Risk Analysis Of Olympic NP Mountain Goat Removal Project

In the winter of 1990, the U/ID/CPSU was asked to prepare a report on the "social risks" of the Olympic NP Mountain Goat Removal Project (Machlis et al 1990). In the report, "social risks" refers to those caused by interacting personnel in the project and the social environment in which they work. The report is based on information collected by a review of relevant literature on social risk and aviation safety. It provides a review of the task of mountain goat removal from Olympic NP and a summary of social science research relevant to improvement of safety and performance in similar tasks, leading to identification of methods that can improve safety, reliability, and performance.

The social sciences have devoted much attention to individual, group, and organizational behavior, and they provide a useful perspective from which to assess and improve safety. Task requirements of complex helicopter flights, difficult capture of goats from the air, and handling of goats on rugged terrain combine with social factors that influence the capabilities of personnel to operate safely and reliably for intensive periods during the summer. The combination of these specifics creates physical and social hazards for personnel.

While humans apparently are capable of completing complex tasks in difficult environments, the evidence shows that humans also are variable in their capabilites. The literature suggests that human variability can interact with task requirements and technical components in such a way that accidents and mishaps occur. The research has identified a number of factors that contribute to variability in human behavior and decision making-*factors that may be rooted in the physical, physiological, or social characteristics of individuals and their work environment. Several important issued were reviewed, including (1) individual characteristics such as decision making and judgments, attitudes and motivation, mental workload, stress, and fatigue; (2) group characteristics including decision making and stress, and (3) organizational characteristics such as constraints on behavior, hazard management, and training.

As tasks and interactions of machines and people become more complex and the situations in which they must be performed become more difficult, the likelihood of accidents grows. Any person, regardless of skill and experience, can contribute to, or cause, an accident at any time. To accommodate the always present possibility of human error, systems should be designed to be "goof proof" and provide buffer zones that mitigate potentially dangerous consequences of mishaps and accidents. Systems that push the bounds of human and mechanical capabilities are also pushing the luck of those involved.

The specific requirements of each stage of the task can create a complex and dangerous set of activities that is not "goof proof." For example, social factors can create sources of stress and high workload, lead to

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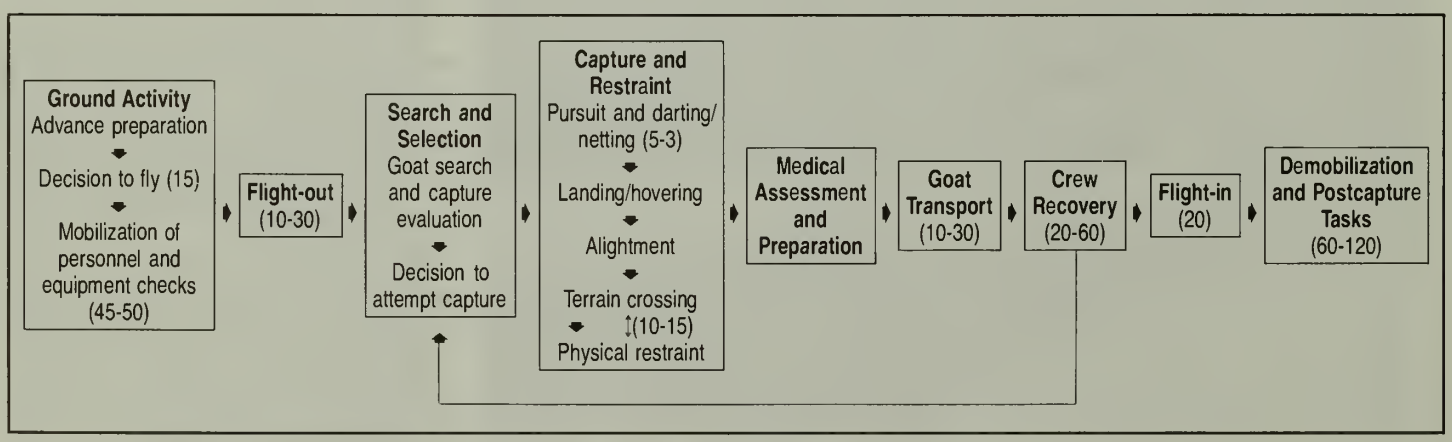


Figure 1. Stages of the technical task (minutes)





Recently captured mountain goats *arriving at the staging area of Hurricane Ridge. (Olympic Natl. Park Photo by Janis Burger)*



***Removing the special carrying sling** from a mountain goat before transport by the WA Dept. of Wildlife. (Olympic Natl. Park Photo by Janis Burger)*

difficulties in interpersonal relationships, and influence organizational planning. Three important levels can influence and shape performance:

(1) individual factors, including "subculture" attitudes and personal characteristics;

(2) interpersonal factors, including group planning activities and communications, and

(3) organizational factors, including liaison among agencies and agency mission requirements.

Hazards to individuals result from failures in goat capture and removal tasks (e.g. technical failures, human errors, or mismatches between demands and personnel capabilities). Two principal types of hazard to personnel in the mountain goat project are:

(1) physical injuries, including back pain, abrasions, sprains, fractures, accidental drug overdose consequences, and death; and

(2) psychological, social, or economic dislocations such as a loss of confidence in management or one's peers, loss of wages or career opportunity, loss of self-image, impacts on one's family, stress, and anxiety.

Our analysis of the social science literature and the task suggested that specific changes might be useful to enhance safety, reliability, and performance. Suggestions for improving safety and performance were of four types:

(1) altering the task to reduce social risk factors;

(2) altering the social environment to reduce social risk factors;

(3) monitoring social risk factors associated with the task, and

(4) additional options, such as the role of training.

The authors presented these recommendations to park personnel at a May 1990 workshop.

Expanded Applications

The review of social risk factors in the Olympic NP project has importance for other NPS programs. While specific activities and characteristics of the task at Olympic are unique, the objectives of wildlife translocation and removal are common to a number of programs in the U.S. and abroad. Deer have been the subject of translocation and removal programs in Florida, Big Bend NP, and New Zealand; wild horse and burro removal has taken place at Grand Canyon and Death Valley, and big horn sheep operations occurred at Lake Mead and in Idaho. Common features have included use of dart or net guns, helicopters, specialized restraint techniques, decision making and judgment difficulties, and the interactions of individuals and organizations. Many of the social factors that influence risk and the hazards faced by personnel also are similar. Thus, the perspective used in this report and the analysis of social risk factors can be usefully applied in a much broader context.

The Office of Aircraft Safety also reviewed the project in the spring of 1990. While they had been informed of the project during its early stages in 1988, the OAS had never formally reviewed it for safety. In January 1990, an OAS Operational Procedures Memorandum (#90-5) was issued that prohibits, because of their dangerous nature, certain types of helicopter flight manouvers: toe-in landings, single-skid landings, or step-out landings, unless prior written examptions are obtained. The performance of the mountain goat removal project requires the use of toe-in and single-skid landings for almost all goat captures. These are landings that require full power to be maintained and during which the helicopter is not completely at rest on the ground.

In addition, although they had allowed the program to continue for two years, the OAS now believes that the helicopter flights are among the most dangerous it has seen in federal aviation programs. The outcome of the OAS team's review was not to provide exemption for such landings during the summer of 1990. This required cancellation of the project for that summer.

Future Plans

Termination of one-skid landings essentially eliminates live capture as an option in removing Olympic's remaining goats. While other capture methods are available, none has proven workable in terms of effective rate or reasonable cost.

Efforts in the summer of 1990 focused on completing field work on vegetation impacts, primarily along the park's eastern periphery where endemics occur in relatively high concentrations. Another goat census also was conducted. The total population on the Peninsula now is calculated at 389 plus or minus 106. This is a substantial decrease from the 1,175 plus or minus 171 counted in 1983. The live capture program can be credited with only a portion of the decrease. Park personnel believe environmental factors such as abnormal temperatures and snowpack may have had at least an equal impact.

An EIS is now in preparation. Currently only two alternatives are being considered: terminating all goat removal operations and allowing the population to return to pre-removal levels, or eliminating the remaining goats by shooting. The latter alternative will also propose making the entire park goat-free. An earlier Environmental Assessment required a goat-free core area and a 50 percent reduction in the subpopulations along the park's east side. The abundance of endemic vegetation in this area precludes goat control as an effective option in protecting these plant communities.

Regional, if not national, public interest is expected to run high once the draft EIS is distributed. While the park has long maintained a running dialogue with animal activist and sportsman groups, shooting remains an emotion-charged issue in spite of broad agreement that goats have no place in Olympic's otherwise natural environment. A classic case history is thus about to take another unpredictable turn, with no absolutes and no "right" answers.

Tuler is a research assistant with the NPS/CPSU at Clark University in Worcester, MA; Janda is Chief Park Ranger at Olympic NP.

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Machlis, G., S. Tuler, and R.E. Kasperson (1990). A Social Risk Analysis of the Olympic National Park Mountain Goat Removal Project. National Park Service Reference #D-173.

Alaska Region

North Pacific Salmonid Enhancement Programs and Genetic Resources: Issues and Concerns (see Publications, p. 19 this issue), documents and evaluates the effects of fish hatcheries on wild salmonid fish stocks in all states, provinces, and countries bordering the North Pacific Ocean. The authors, who are with the Arctic Environmental Information and Data Center at U/AK, Anchorage, paid particular attention to prediction and mitigation of probable genetic and wild stock over-harvest effects with expansion of the Sikusuilaq Springs chum salmon hatchery on the Noatak River in NW Alaska.

Ross Kavanagh, ARO Regional Fishery Biologist, adminstered the report through numerous drafts and extensive peer review over an 8-year period. The careful reader will note resource management connotations beyond the field of fisheries. Copies of the 250-page report, including an 80-page annotated bibliography, may be had from the ARO Chief Scientist or the NPS National Publications Coordinator in Denver.

* * *

Three Alaskan Parks now have new research biologists: Kurt Jenkins from South Dakota State U to Wrangell-St. Elias NP, Jeff Kaye from Yosemite NP to Denali NP, and Jim Taggart from UC/Santa Cruz to Glacier Bay NP.

* * *

Three new resource management specialists in Alaska are James Benedict (Denali), Ken Faber (Gates of the Arctic) and Bill Route (Wrangell-St. Elias).

* * *

Dale Taylor was one of three MAB High Latitude Ecosystems directorate members attending a Northern Sciences Network meeting in Ravaniemi, Finland, Sept. 27-Oct. 1, 1990. Representatives from Finland, Norway, Sweden, Canada, USSR, Denmark, and France discussed international networking, long term ecogical research and monitoring, sustainable development, and status of biosphere reserves in various countries.

* * *

In the fall of 1990, Layne Adams gave invited seminars at Texas A&M U and Colorado State U on his predator/prey studies, done at Denali and Gates of the Arctic.

* * *

Victoria Harmon recently joined the Division of Natural Resources GIS staff. She has a BA from U/CO and an MA in remote sensing from U/IL in 1989. While employed at the Army Engineers' Construction Engineering Research Lab in Champaign, IL, she was involved in development, documentation and testing of GRASS software and applications projects using GRASS.

Southwest Region

Buffalo is collaborating with Ozark National Scenic Riverways in the Midwest Region to develop an Operations and Conceptual Research Plan (O/CRP) for the Ozark Uplift biogeographical region as one of the 11 areas to participate as a core research area for determining global change effects, starting in FY 1991 or 92. A workshop was held in early September to select the site from which the project coordinator will work, to prepare the position description for the coordinator, to develop the O/CRP, and to link with researchers in the area for this initiative.

* * *

Work is proceeding to evolve the Capabilities and Interest Statements (C/ISs) for Big Bend, Bandelier, and El Malpais for further consideration by the Servicewide Global Change Program. Meetings were held in August and September to foster a joint effort among researchers and park staffs toward participation in this program in FY 1992 or 93.

* * *

Staff members of the Region's Division of Natural Resources Management and Science prepared papers for the George Wright Society's El Paso meeting in November on the following topics:

– an analysis of the high priority projects enumerated in SW Region park RMPs in the early 1980s compared to those in the RMPs of the late 1980s as to how many have been funded and/or completed fully or in part;

– an assessment of Integrated Pest Management progress in SW Regional parks in the 1980s;

– pesticide levels in selected NPS areas; and

– A computerized method of counting wildlife numbers using video tape recordings.

* * *

A Geographic Information Systems (GIS) open house was held Sept. 1, 1990, in the Regional office to inform management and SWRO non-specialists of the Region's progress in GIS and to demonstrate the two GIS systems (EPPL7 and GRASS) being used. Substantial data bases are operational for Big Thicket, Big Bend, Bandelier, and Padre Island. Data bases are being formulated for Lake Meredith, Buffalo, Capulin Volcano, El Malpais, and Hot Springs. The use of a read-many write-many optical disk device has greatly simplified storage and access of images and appears to be the technology of the future.

* * *

SWR continues to be active in Integrated Pest Management programs. IPM inspections were made in 24 percent of the SWR parks during the past FY. These inspections also provided opportunities to hold onsite, practicaly training for IPM coordinators.

* * *

An attempt to control water hyacinth with an agricultural vapor flamer at Jean Lafitte NHP&P showed hyacinth to have considerable resistance to heat. Additional experimentation with liquid torches may be conducted. Because some park areas cannot use open flame for weed control, SWR has purchased equipment to develop a portable hot air generator.

* * *

Cooperative efforts among the SWR, USFS, and the Animal and Plant Health Inspection Service for gypsy moth detection trapping did not show any sources of infestation at NPS sites in Arizona or New Mexico.

* * *

NPS and USFS have made a cooperative effort to classify hazardous trees in SWR parks. Actual work began in October 1990, and park employees trained in this program may be available for assistance to other parks and Regions.

* * *

SWR continues to cooperate with the USFWS in protecting endangered plants and animals and serves on a task force considering needs to list the Mexican spotted owl. *(See page 18 box.)*

Southeast Region

Jim Wood, Technical Publications Editor, NPS-SERO, and former Servicewide editor of the NPS Scientific Monograph Series, has accepted a position as writer/editor with the USFWS, Branch of Project Development, Office of Refuges and Wildlife, Southeast Region. Wood exited his SERO service with a $1500 Special Achievement award for his "cost efficient, knowledgeable, aesthetic, and valuable expressions of scientific work." The award also noted that Wood "has brought high acclaim to the National Park Service and the researchers who serve the agency" and that "he has performed these services and duties to all in a spirit of altruism."

Wood began his new duties with FWS on Nov. 19, 1990.

Ecosystem-Based Research

Reorganization of the SER office of the Deputy A/RD for Science and Natural Resources will more fully support an ecosystem-based research program. Three divisions have been established under direction of Regional Chief Scientist Dominic Dottavio: (1) Natural Resource Management, (2) Coastal and Marine Ecosystem Research, and (3) Terrestrial Ecosystem Research.

Rick Dawson, chief of the natural resource management division, is responsible for the Region's resource management planning, minerals, oil and gas, GIS, endangered species, wildlife, integrated pest management, air quality, water quality, vegetation management, publications, and social science.

Gary Hendrix, chief of the coastal and marine ecosystem research division, and Susan Bratton, chief of the terrestrial ecosystem research division, are responsible for administering research in their respective areas. This includes preparation of ecosystem research plans, inventory and monitoring proposals, and proposals for WASO special initiatives; supervision of the Region's field scientists and research projects; and development of cooperative research programs.

Research positions supported by Regional funds will investigate questions of regional scope as well as park-specific issues. The field scientists are assigned to either the chief of coastal and marine ecosystem research or the chief of terrestrial ecosystem research.

SER Director Bob Baker expressed belief that these changes "will focus existing financial and manpower resources, make our Region and parks more attractive for funding and cooperative programs with other agencies, and establish a more consistent research policy among the parks."

James R. Snyder (Big Cypress NP) and Alan Herndon and William B. Robertson, Jr. (both of Everglades NP) co-authored a chapter entitled "South Florida Rockland," published in ***Ecosystems of Florida*** (see Publications, p. 19 this issue). The chapter (pp. 230-277) describes the tropical hammocks and pine-

lands that occur on limestone in south Florida. Copies of the chapter are available from Snyder at Big Cypress National Preserve, S.R. Box 110, Ochopee, FL 33943.

• • •

Recent analysis of ambient surface water quality in Cape Hatteras NS indicates that the seashore is being affected by moderately degraded septic outflows from the neighboring town of Nags Head. Andrew Cole, NPS/CPSU at NC/State/U, has found high levels of fecal coliform bacteria in the canals and ditches draining Nags Head through the seashore. Since the water samples also contain low levels of optical brighteners, a man-made dye used in laundry detergents, Cole suspects the pollution may be coming from underground septic sources. This would suggest an extensive subsurface transport system in which the septic effluent moves through the groundwater. Nags Head officials are being kept informed of the study and have expressed interest in working with the park to solve the problem. The study, with recommendations, is scheduled for July 1991 completion.

• • •

Two graduate students working with the NPS/CPSU at U/GA have won awards for their research efforts.

Bart Johnson won first place in the 1990 American Society of Landscape Architects (ASLA) National Student Design competition in the research category for his "Rare Plant Habitat Protection" project on the Blue Ridge Parkway. Bambi Teague of the Blue Ridge Parkway and Susan Bratton of the U/GA CPSU assisted Bart in this project.

Jim Boone, formerly a seasonal ranger at Sequoia-Kings Canyon NP, received the Stoddard-Sutton-Burleigh award for his thesis and published work on the genetics of a Cumberland Island (GA) population of the cotton mouse, *Peromyscus gossypinus*. (See ***Park Science***, Fall 1990, p. 7). The award is given annually by U/GA for outstanding achievement in wildlife conservation.

Western Region

The Sequoia and Kings Canyon NPs Second Century Conference was held in Giant Forest Oct. 5-7, 1990, in honor of the 100th anniversary of Sequoia NP and the 50th anniversary of Kings Canyon NP. Designed to address issues facing these parks in the coming century, the conference brought together people from conservation groups, concessionaires, special interest user groups, park management, and the general public. RD Stan Albright, Supt. Tom Ritter, and Conference Coordinator Bill Tweed welcomed the conferees, who then heard keynote addresses by Dale Crane (NPCA), Boyd Evison (AK RD and former SEKI superintendent), Jerry Franklin (USFS ecologist), and Norman Livermore (retired packer and conservationist).

Special workshops were held on Purpose of the Parks, Limits to Frontcountry Growth and Use, Backcountry Use, Adjoining Lands, and Regional and Global Issues. A proceedings, including the principal addresses and working group recommendations will be prepared.

• • •

David Parsons presented an invited paper at the UC/Davis Landscape Ecology Conference (Oct. 3-5) in Sacramento, CA. His topic was "Managing the Greater Sierran Ecosystem: The Landscape Dimension." This presentation, together with one given later in the month at the Yosemite Centennial Symposium and Natural Areas Assn. annual meeting, addressed the growing importance and interest in a regional, interagency approach to science and management in the Sierra Nevada.

• • •

Five technical reports and one special report have been completed by CPSU at U/AZ. They are:

Baisan, Christopher H. Fire History of the Rincon Mountain Wilderness, Saguaro NM. Tech. Report #29.

Duncan, Douglas K. Small Mammal Inventory of Chiricahua NM, Cochise County, AZ. Tech. Report #30

Reichhardt, Karen. Autecology of Arizona Sycamore (*Platanus wrightii* Wats.), A Critically Important Species in South-Central Arizona. Tech. Report #33.

Despain, D.W. and J.C. Mosley. Fire History and Stand Structure of a Pinyon-Juniper Woodland at Walnut Canyon NM, AZ. Tech. Report #34.

Bennett, P.S., R.R. Johnson, and M.M. McCarthy. Assessment of Scientific Information and Activities at Organ Pipe Cactus National Monument Biosphere Reserve. Special Report #10.

Copies of these reports may be had by contacting the CPSU at Tucson, (602) 670-6885.

• • •

Mary Ann Madej, Geologist at Redwood National Park, and Dr. Thomas Lisle of the U.S. Forest Service presented an invited talk titled "Spatial variation in armoring in a channel with high sediment supply" at the Third International Workshop on Gravel Bed Rivers held in Florence, Italy September 23-28, 1990. The paper will be published by John Wiley and Sons in a book entitled "Gravel Bed Rivers." Mary Ann Madej received an award from the Horace M. Albright Employee Development Fund to attend this meeting.

Pacific Northwest

The Pacific Northwest National Park and Forest Association at 83 S. King St., Seattle, WA 98104, officially became the Northwest Interpretive Association as of Oct. 1, 1990.

News of the name change came from Executive Director Mary Ellen Rutter, who also announced that the association is selling (for $10 each, plus $2 mailing charges) 75th NPS Anniversary T-shirts sporting the diamond logo in green and blue on white, in sizes S, M, L, and XL.

• • •

Two lakes on opposite sides of the world – Crater Lake in Oregon and Lake Baikal in the Soviet Union – share one unusual similarity: they are the only known freshwater lakes in the world that may have hot springs on the bottom.

Grigory I. Galazy, a Lake Baikal scientist and director of the Baikal Ecological Museum, is one of two Soviet scientists who visited Oregon in October 1990 as part of an exchange program. "We're counting on the fact that between our lake and Crater Lake there will be some definite organized cooperation in the future," Galazy said after taking his first look at Crater Lake.

The visit came two months after a Soviet-American team found evidence of a hot vent field in Lake Baikal. The vent area, which lies about 1300 feet down at the lake's northeastern corner, supports a community of sponges, bacterial mats, worms, snails, and fish. The sponges are white and grow in circles. The spring area is significantly warmer – as much as 24 degrees F warmer – than the water surrounding it.

Oregon State University oceanographers Jack Dymond and Robert Collier are completing a draft report for NPS of the 1990 summer research in Crater Lake, where the pair found the warmest temperatures ever detected in the lake – 66 degrees F – in a bacterial mat on the lake's floor. The reading was 28 degrees higher than the surrounding water temperature.

Removal of Dams Essential To Ecosystem Restoration

In the Fall 1989 issue of ***Park Science***, John Aho and John Meyer reported on the effort by Olympic NP to restore anadromous fish into the upper Elwha River above two hydroelectric dams. While restoration of native salmon, char, and trout runs is the objective, the overriding goal is restoration of the ecosystem and natural processes, of which the fish are an integral component.

Olympic NP and several resource agencies (known collectively as the Joint Fish and Wildlife Agencies – JFWA) have been examining two alternatives for restoring these fish resources. The first alternative is provision of state-of-the-art fish passage facilities at the two dams. The second alternative is removal of both dams.

During 1990, the JFWA gathered information and assessed feasibility of restoring 10 endemic stocks of anadromous fish under each alternative. Information assessment showed that under the state-of-the-art alternative, only 4 or 5 of the original 10 stocks could be restored, and the restoration chances of these were only fair. With the dams' removals, chances are fair to good of restoring all stocks.

Olympic also examined potential effects on the ecosystem that would result from restoration under these 2 alternatives. Returning significant quantities of fish biomass was considered to be a critical factor in restoring natural processes. Biomass from fish carcasses, eggs, and juveniles, would be reduced by about 75 percent if the dams remain.

Because of the lower number of stocks that can be restored with the dams in place and the significantly lower biomass available to the ecosystem, Olympic NP has determined that only through removal of the dams can the park's restoration goals be met. USFWS has concluded that the dams should be removed. THE JFWAs are examining methods of removing the dams and stabilizing the sediments stored in their reservoirs. Much work remains before restoration can occur, but Olympic NP staff are encouraged over the possibility of restoring natural processes in this 175,000 acre watershed.

John Meyer
Olympic NP Fishery Biologist

Rocky Mountain

The results of a 2-year survey for threatened and endangered plants in Zion NP have been received. In order to determine what species might be threatened or endangered, all species seen were identified. A total of 161 plants was added to the list of those known from the park, including a new variety of *Lomatium* and a

Rocky Mountain *(Continued)*

new species of *Carix,* increasing the plant list for Zion from 738 to 899 species.

Some of the plants located during the survey were new State records. *Valeriana arizonica* was found on the West Rim trail. This species was collected by Walter P. Cottom in the park about 60 years ago and it had not been identified again until this survey. Over 20 species of endemics were discovered by the survey. Many isolated areas including the large free-standing mesa tops were not covered, and further research is needed to complete this work.

* * *

A recent meeting at Zion NP ended the first phase of the development of a step-down plan to guide research and resource management over the next 10 to 15 years. Charles Van Riper III, from the Northern Arizona University CPSU, provided the guidance for developing the plan's components. Professors from several universities and colleges participated in working out the plan's framework and assisted in determining work priorities. Baseline inventories for each resource discipline also have been developed. Further work will create a similar plan for cultural resources.

* * *

In August, a single bison (*Bison bison*) was translocated from Wind Cave NP to Grand Teton NP in an effort to maintain genetic variability in Grand Teton's relatively small, genetically isolated bison herd. The introduction was called for in the Annual Management Program for the Jackson Herd, which is developed every year by agencies sharing jurisdiction for managing the herd, including the NPS, USFS, USFWS, and Wyoming Game and Fish Department. The Jackson herd, now numbering approximately 120 animals, summers in Grand Teton NP and winters on the National Elk Refuge in Jackson, WY. Coordinated by Grand Teton biologist Steve Cain and Wind Cave chief ranger Steve Bone, the translocation was the first involving the Jackson herd since 1963 when 10 bison were introduced from Theodore Roosevelt NM.

The Wind Cave bison herd was chosen as the donor population because it has the highest level of heterozygosity known among several western herds that have been tested. The yearling female bison, selected because a young female is most likely to make a significant genetic contribution, was field-immobilized, corralled and observed for a few days by Wind Cave personnel, and then transported via horse trailer by Grand Teton biologists. Even though released in sight of the Jackson herd, the introduced animal remained solitary for about 3 weeks before finally joining the other animals. She was fitted with ear tags and a radio collar, so that her movements and reproductive status can be monitored on a regular basis. Park biologists anticipate that she will breed during the 1991 season. The success of this major effort can to a large degree be attributed to the outstanding level of inter-park cooperation brought about by both Grand Teton and Wind Cave personnel.

* * *

A deer drive was conducted at Devils Tower NM on Oct. 20, 1990 to get a census count of the population within the park. The drive was organized by co-principal investigator Evelyn Merrill and research technician Greg McDaniel and included U/WY students, Moorcroft Search and Rescue and park personnel. The drive people were split into two groups to cover the 1346 acre park which is bordered by a game-proof fence on its north and west boundary. One group of 25 people lined the north boundary and walked together to the south boundary and the other stationary group lined the east and south boundary. Deer were counted that passed through the walking line and the line on the boundaries. A total of 180 deer were counted – 117 whitetail and 63 mule deer. From comments after the census it is believed 20 percent of the deer on the Monument were missed. This drive is part of a three year study of deer in the park which includes monitoring of deer daily and seasonal movements from the 16 radio-collared doe deer and extensive habitat analysis of the area.

* * *

Dr. Paul Buchheim recently completed the first of three field seasons in the Fossil Lake Basin, of which Fossil Butte NM is a part. He will collect similar time horizon samples at 70 locations over a three-year period. Analysis of these samples will give important insight into lake depth, salinity, temperature, faunal elements and climate changes through time.

The results of this study will be a series of 10 "time slice" maps, which will portray Fossil Lake throughout its history. An understanding of these aspects of Fossil Lake will also allow us to relate the Eocene climate changes to changes taking place in present day lakes and oceans. Similar research is being conducted at the Salton Sea in California. Comparisons can be made between the modern and ancient lake systems.

Mexican Spotted Owls Shyer Than Their Northern Cousins

The controversy surrounding the habitat needs and population status of the northern spotted owl (*Strix occidentalis caurina*) has led inevitably to concern about the Mexican subspecies (*Strix occidentalis lucida*). Therefore, a study of abundance and distribution of Mexican spotted owls in Zion NP was made in 1989 and 1990. During the 2-year study, vocal imitations were used to elicit responses from the owls. A 45.7cm diameter plastic parabolic dish and microphone was used in listening for the owls and to monitor calling between pairs. Remote and inaccessible areas also were surveyed by using the parabolic microphone. In some instances, the owls would not respond to vocal imitations, so the parabolic microphone was used to listen for vocalization between pairs.

The monitoring sessions usually lasted from 8 p.m. to 5 a.m. Vocal imitations were done for 10 minutes each hour; the remaining 50 minutes were used to listen for responses. The survey efforts turned up 6 pairs and 4 individuals in 10 different locations. Some banding of both adults and juveniles was accomplished.

Spotted owls are widely distributed in Zion and their locations appear to follow a patchily distributed habitat. Owls were found inhabiting steep-walled canyons and deep gorges. Detecting Mexican spotted owl responses in this country appears to be more difficult as compared to the northern subspecies in the Pacific Northwest. This makes the parabolic dish necessary for locating the owls throughout the rugged terrain of Zion NP.

In October 1990, staff at Bryce Canyon NP conducted the first in a series of prescribed burns planned for 2000 acres in the northwest part of the park. Fire suppression and past livestock grazing altered fire frequency in the park, thereby changing fuel loads, vegetation structure and species composition. Park staff and university scientists have been collecting baseline data needed to plan prescribed burns since 1980. Plant community type, habitat type, and fuel load maps have been prepared, and fire history has been studied. Monitoring programs for vegetation, fuel loads, birds and small mammals have been established, and fire effects on these resources will be evaluated. Fires are planned for remaining burn blocks during each spring and fall through 1992.

* * *

Region is entering its third year of a peregrine falcon recovery program. Parks with peregrine populations will by the end of the year have completed intensive and complete surveys as well as the development of a long term monitoring plan to selectively sample portions of park populations.

* * *

The Region is prepared to initiate in FY91 an unprecedented effort in surveying Colorado Plateau Parks for Quaternary resources. Although continued discoveries of extinct ice-age mammals such as mastodons and mammoths appear irregularly, no systematic evaluation has yet been made.

* * *

Grand Teton and Yellowstone parks hosted a service-wide level tour for participants interested in ongoing research and application of native plant materials to disturbed areas within parks. Application of research findings and use of the plant materials program and expertise of the Soil Conservation Service may have significant input towards future revegetation attempts in parks.

Guide to Florida's Natural Resources

On Nov. 15, 1990, the University Presses of Florida published the first comprehensive guide to Florida's natural resources in 60 years. The book (728pp) is titled ***Ecosystems of Florida,*** edited by Ronald L. Myers and John J. Ewel, with a foreword by Marjorie Harris Carr.

In straightforward text supplemented by charts, maps, and illustrations, ***Ecosystems of Florida*** provides what Patrick Smith, author of ***A Land Remembered,*** calls "a treasure chest of fascinating information about Florida – both past and present ... and an intimate understanding of why Florida is what it is."

At a time when population growth and development are straining the state's natural resources as never before and involving the National Park Service in Herculean efforts to save Everglades NP, this book provides a scientific benchmark for each of the peninsular state's complex, fragile environments ... an assessment of the character, relationships, and importance of Florida's ecosystems, the organisms that inhabit them, the forces that maintain them, and the agents that threaten them.

Ecosystems of Florida is available in cloth ($75) and paper ($29.95) from University Presses of Florida at Gainesville, 15 NW 15th St., Gainesville, FL 32607; (904) 392-1351.

publications

The following new publications produced by the NPS publications program, are available from NPS Publications Coordinator Donna O'Leary, NPS Natural Resource Publications Office, c/o Air Quality Division (AIR)m PO Box 25287, Denver, CO 80225-0287. (303) 969-2156.

North Pacific Salmonid Enhancement Programs and Genetic Resources: Issues and Concerns, by Michael D. Kelly, Patricia O. McMillan, and William J. Wilson. 232pp.

1989 Inventory of Research Activities in the National Parks (second annual science report), 386pp.

Protecting Biological Diversity in the National Parks: Workshop Recommendations, edited by Dominic Dottavio, Peter F. Brussard, and John D. McCone. 79pp.

Examples of Resource Inventory and Monitoring in National Parks of California, edited by Charles van Riper III, Thomas J. Stohlgren, Stephen D. Veirs, Jr., and Silvia Castillo Hillyer. 268pp.

Role of Biological Control As a Management Tool in National Parks and Other Natural Areas, by Donald Gardner. 41pp.

Annual Report of National Park Marine Debris Monitoring Program: 1989 Marine Debris Survey, by C. Andrew Cole, John P. Kumer, David A. Manski, and Daniel V. Richards. 31pp.

Highlights of Natural Resources Management 1989. 39pp.

Shenandoah National Park Long-term Ecological Monitoring System User Manuals. Approx. 300pp, consisting of 5 Sections: Overview, Forest Component User Manual, Aquatic Component User Manual; Gypsy Moth Component User Manual, and Database Management System Component User Manual; the work of eight editors from Shenandoah NP and Virginia Polytechnic Institute and State University.

An Index Bibliography of Wildlife Research in the U.S. National Parks, compiled by R. Gerald Wright. 134pp.

Some of these books either have been or will be given further review in these pages.

Isle Royale Book Wins Award

Moods, Magic and Mystique, the Isle Royale Natural History Association's color publication about Isle Royale NP, has won first place, as well as the prestigious Directors Award in the NPS Cooperating Associations publication competition. Approximately 200 new publications were entered in the nationwide competition.

The judges included ***National Geographic*** art director and the National Gallery of Art's editor-in-chief. Their comments: "Covers and title pages are knockouts. A beauty throughout, gorgeous photography, beautiful book, beautifully produced, profoundly poetic ... mood-creating photos match the evocative text."

The book may be had from Isle Royale NP headquarters, Houghton, MI 49931. Bruce Weber, park naturalist and Association Coordinator, can be reached at (906) 482-0986.

George Wright Society Sixth Conference

The George Wright Society's Sixth Conference on Research and Resource Management in the National Parks and Equivalent Reserves, held in El Paso, Texas, November 12-17, 1990, was a highly successful communion of diverse people concerned with the future of parks. The nearly 400 participants from federal science, resource management, park management, and interpretation, academia, and other sectors gave and heard papers ranging from the spiritual, political, and regional dimensions of park resource management to hazardous trees and threats to the winged mapleleaf freshwater mussel.

The sessions were organized by types of threats to parks, and the first product of the conference was a vote on the five most critical threats – as a guide in identifying issues for the George Wright Society to focus on in the 1990s. The top five were global climate change, animal population management, monitoring of park resources, communication of threats to parks, and external influences, not necessarily in that order. The Society has been enabled to put more effort into such issues by the generous gift of $277,000 from a daughter of George Wright, Mrs. Sherry Wright Brichetto, who was honored at the conference.

Several speakers applauded the sizeable representation of top NPS management, which included two former Directors, three Associate Directors, six Regional Directors, four Deputy Regional Directors, and a number of superintendents. Director Ridenour, unfortunately, was called away at the last minute by urgent business in Washington. Also absent were large numbers of people from the cultural resource side, a deficiency the George Wright Society hopes will be remedied at future conferences.

Co-chairmen Tom Gavin (program organization and overall coordination) and Frank Smith (local arrangements) received thunderous applause for putting together a well-organized, enjoyable conference that informed and reenergized all present to pursue the mission of parks in our complex world.

The conference papers will not be published in a Proceedings, but some will appear in the ***George Wright Forum.*** Other papers may be obtained from the authors.

Napier Shelton
NPS Washington Office

meetings of interest

1991

March 4-8, "FROM DESIGN THROUGH CONSTRUCTION: THE CONTINUUM OF EXCELLENCE," workshop sponsored by the Department of the Interior and the Denver Service Center, at Colorado Springs. Four areas to be covered are Design and Construction Theory and Practice, Project Management, Contracts, and Communications and Negotiations.

March 22-27, 56TH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE, at the Edmonton Convention Center in Edmonton, Canada. Theme, "Sustaining Conservation: An International Challenge." Documentation required for foreign travel must be in the AD/NR's office by end of January.

May 14-19, INTERNATIONAL CONFERENCE ON SCIENCE AND THE MANAGEMENT OF PROTECTED AREAS, at Acadia University, Wolfville, N.S. Canada. To serve as a forum for examining current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research, and as a lead-up to the IUCN World Parks Conference, 1992. Contact Neil Munro, Director, Policy Planning & Research, Canadian Parks Service, Atlantic Region, Environment Canada, Historic Properties, Halifax, Nova Scotia, Canada, B3J1S9.

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

May 29-31, 12TH ANNUAL MEETING OF THE SOCIETY OF WETLAND SCIENTISTS, at Ann Arbor, MI, covering wetlands research and management from many different disciplinary approaches. Contact: Douglas A. Wilcox, USFWS, National Fisheries Research Center-Great Lakes, 1451 Green Rd., Ann Arbor, MI 48105; 303/994-3331.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact, Vice President, Programs Service and Information, National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, DC 20036.

October (no date given in ititial announcement), SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme, "Wildland/Urban Interface," at Lake Tahoe, interfacing resource managers and scientists in small group discussions of research findings. Sponsored by USFS, BLM, Society of American Foresters and others. For information write Debbie Chavez, SARR Symposium Coordinator, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

Nov. 4-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL, in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Contact: Gabriel Cherem, EMU Geography & Biology, Ypsilanti, MI 48197; (313) 487-0218, or Ray Tabata, UH Sea Grant, (808) 948-3191.

Rare Plant Monitoring and Management at Point Reyes

By Gary M. Fellers and Virginia Norris

Rare plants are not assured of survival simply by growing on lands protected by public parks. Their preservation also demands careful, long-term monitoring and, from time to time, well-designed intervention. Most parks have limited resources and may find it difficult to provide sufficient protection for their rare plants. Point Reyes National Seashore (NS) has developed a cooperative program with the California Native Plant Society (CNPS) to monitor and manage rare plants.

The Seashore, located 40 miles north of San Francisco, includes sandy and rocky beaches, coastal prairie, Douglas fir and Bishop pine forests, chaparral, and wilderness lakes. About one-third of the Seashore is designated a pastoral zone with both dairy and beef cattle ranches. In large part due to the wide diversity of habitats, strongly maritime climate, and southern geological origin, Point Reyes has a remarkably diverse flora with 828 species and an additional 35 varieties and subspecies. About 16 percent of the entire California flora is represented in an area of only 114 square miles.

Not surprisingly, this diverse flora includes a significant number of rare plants. Forty-two of the species listed in the 1988 edition of the CNPS's inventory of the state's rare and endangered plants have been reported from Point Reyes or are likely to occur within the Seashore. Two of these are presumed to be extinct, four are presumed to have been extirpated from the Seashore, 30 have been confirmed since 1983, and another six are objects of current searches. Four of the 42 species are listed by the State and 33 are candidates for Federal listing.

In the early 1980s, the Seashore had very little information on most of the rare plants, and was concerned that they might inadvertently be threatened by grazing, or that the Seashore's fire management program might have a negative impact on them. From 1983 to 1984, the Seashore conducted a systematic search for rare plants, which documented the occurrence of 21 species. (Clark and Fellers, 1986).

The final report recommended some immediate management actions and outlined an ambitious monitoring program that would allow the Seashore to track rare plant populations and assure their continued survival. The rare plants were to be resurveyed at intervals ranging from one to four years, depending on their rarity and possible endangerment.

The Seashore promptly began some of the specified management, but resources were not available to monitor all the rare plants. Meanwhile, the list of those expected to occur at Point Reyes had increased, due to new information on plant distributions and additions to the CNPS rare plant inventory.

CNPS Volunteers

In 1986, the CNPS contacted the Seashore to volunteer its assistance in monitoring rare plants. A priority list of plants was agreed upon and the Seashore provided copies of the rare plant report, topographic maps, photographs of the plants, and occasional assistance in the field. Weekly field trips were scheduled throughout the spring and were announced in the CNPS newsletter. By the end of that season, 13 CNPS botanists had visited 16 historic sites and had discovered two new populations of rare plants.

The first year demonstrated the success of the cooperative program. The volunteers had shown sustained interest in the project and had been able to relocate



Monardella undulata

and survey known populations of rare plants as well as find new populations. The CNPS leaders contributed a substantial amount of time, not only in organizing and leading the field trips, but also in preparing field survey reports and maps for each visit to every rare plant population. These field forms were filed at the Seashore and a copy sent to state and county CNPS offices as well as to the California Natural Diversity Data Base, which is maintained by the State Fish and Game department.

The cooperative monitoring program has grown considerably since that first year. During the 1989 field season, 34 botanists participated in 27 field days of monitoring. As CNPS botanists became more familiar with Seashore terrain and the habitat characteristics of each new species, they were able to locate many more new populations – 21 in 1988 and 22 in 1989.

The Seashore has continued to participate in the rare plant monitoring on a limited basis. Initially, the list of plants and populations to survey was developed jointly, but planning now is done primarily by the CNPS botanists. Seasonal park botanists have joined a number of field trips and have worked in more detail on selected plants (see below). The Research Biologist has assisted with finding some of the more difficult historic localities and with identification of some of the grasses.

During the first five years of the cooperative monitoring program, 94 people have surveyed for rare plants at Point Reyes. Some came only occasionally, but seven people have averaged more than 50 days each. They have located 29 species of rare plants and have made significant contributions to the knowledge and management of Seashore flora.

Management of Rare Plants

With CNPS volunteers conducting most of the monitoring, the Seashore has been able to focus its resources on managing the most vulnerable rare plants. The species identified as most in need of immediate protection in 1984 was the Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*). In 1985, the Seashore constructed an exclosure around the only known population, to keep cattle out. Over the next several years, the marsh vegetation within the exclosure flourished, but the population of alopecurus declined from 35 plants to one. Clearly the fence was not helping and may even have contributed to the decline by allowing other species of plants to thrive and out-compete the alopecurus. Hence the exclosure was opened in June 1990.

Fortunately the Seashore also had started a greenhouse propagation program using seeds collected in 1986. Alopecurus proved to be easy to raise. The greenhouse provided over 400 seedlings, which were plants in three areas. The outcome of two introductions still is uncertain, but the third has done well, with 62 plants present in 1988 and 85 in 1989. All populations will be carefully monitored during 1991.

An important lesson to be learned from the alopecurus experience is that rare plants cannot

Concluded on page 21



Coastal dune habitat *supports several rare plants, including beach layia and curly-leafed monardella. Here, Myrtles Silverspot is shown on its North Beach habitat.*



Volunteers search *for Sonoma spineflowers at Point Reyes National Seashore.*

always be preserved merely by protecting them from grazing or trampling. Some species are adapted to disturbance or may benefit from the control of competing vegetation. Hence it is important to understand the ecological interactions within the plant community before a full recovery effort is implemented. When immediate action seems warranted because of an imminent threat, it must be done carefully, with constant monitoring of results.

The Seashore is applying this experience to its management of the Sonoma spineflower (*Chorizanthe valida*), a species being proposed for Federal listing. The plant currently is recognized as the most endangered at Point Reyes. While this species has been reported from several other coastal populations, all but the one at Point Reyes now are disputed or believed to have been extirpated. The single Seashore population appears to be healthy, but it does occur in an area that is grazed and the question of grazing impact has again been raised.

This time the Seashore has taken a more experimental approach by protecting a small number of plants with test exclosures while leaving most of the population alone. Thus far it appears that the spineflower does better with grazing (Davis and Sherman, 1990). Further monitoring and competition experiments are planned.

Another plant of current interest is the Point Reyes lupine (*Lupinus tidestromii* var. *layneae*). Because of the loss of coastal dune habitat, the Point Reyes lupine is being proposed for Federal listing as a threatened species. At Point Reyes, the lupine is known from one extensive and four small populations. The larger site has been trampled by cattle with an obviously detrimental effect on the lupine and other dune species. The Seashore has now fenced the dunes to protect both the dune vegetation and nesting Snowy Plovers.

At least one, and possibly more, of the other lupine sites are threatened by non-native iceplant (*Carpobrotus edulis*). The CNPS botanists have documented the increasing threat from iceplant to the lupine as well as to two other rare dune plants, the beach layia (*Layia carnosa*) and the curly-leafed monardella (*Monardella undulata* var. *undulata*). While the iceplant problem seems almost overwhelming in some areas, the Seashore has begun removal experiments and currently is working on one small dune restoration project. Iceplant at that site was removed by bulldozer and native dune species are being tested for their ability to stabilize windblown sand along roads.

Overall, rare plants at Point Reyes NS are doing well. The cooperative program between the Seashore and the CNPS has allowed the Seashore to track the status of rare plants while conducting essential management of the most vulnerable species. The Seashore now regularly consults the CNPS botanists, or the extensive rare plant files, about proposed projects that might affect rare plants. As a result, the chance of accidental damage to rare plants has been greatly reduced.

The experience of the past four years clearly demonstrates that this close partnership has produced a valuable program for pretecting an important segment of California's rare flora.

Fellers is the research biologist at Point Reyes NS; Norris is a member of the Marin Chapter of the CNPS and current leader of the CNPS volunteers.

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Chorizanthe valida



Layia carnosa

Rabbits Invade Haleakala NP

Even though oceanic islands are known to be highly vulnerable to biological invasions, conventional wisdom has held that escape or release of domestic rabbits (*Oryctolagus cuniculus*) poses no significant threat to native Hawaiian ecosystems or local agriculture. This assumption is now obsolete.

Haleakala NP initiated rabbit removal and monitoring in July 1990, following discovery of a reproducing population covering about 25 ha in high elevation (2070-2140 m) native shrubland. Because of the perceived threat of an established rabbit population, rabbit eradication was placed as the #1 park priority.

Through a complex series of inquiries, it has been learned from the person who released the apparently colonizing animals that six rabbits were released in October of 1989. This date coincides with the month of the first record of a rabbit in Haleakala NP – an injured animal which appeared to have been attacked by an Hawaiian short-eared owl. In spite of possible predation by owls, mongooses, and feral cats (7 mongooses and 6 cats trapped within 2 km during January-October 1990) and winter weather (1186 mm or 47 inches of rain fell in the area during November-March), the cage-reared animals managed to persist and reproduce.

As of Oct. 24, 1990, 79 rabbits had been removed, through snaring (45), shooting (24), and trapping (10). Fencing has been used to separate control efforts from an active campground. Monitoring of transects (assessment of rabbit pellet presence/absence, age, and abundance), suggests that areal expansion of the population since its discovery has been minimal and that control is significantly reducing the population. Simple calculations suggest the conclusion that without prompt eradication efforts, rabbits would have numbered in the millions within five years of their introduction.

Meanwhile, the park is faced with the awesome responsibility of attaining complete eradication.

Lloyd Loope and Peter Connally
Haleakala NP
Box 369
Makawao, Maui, Hawaii 96768

Special Initiative Funding For Servicewide Projects Now Into Second Year

In November 1989, a call went out to NPS Regional Directors from the Associate Director for Natural Resources (AD/NR), for "pre-proposals for substantive technical investigation of two critical issues of Servicewide importance:

– The management of animal populations

– The role of diseases and parasites in natural ecosystems."

The first of these issues had been identified by NPS Regional Chief Scientists as a high priority; the second is emerging as a significant national problem as parks become more and more surrounded by intensive human developments and activities.

A number of excellent pre-proposals emerged, many of them involving cross-Regional staff work in a Servicewide partnership. Seven were chosen for funding in FY 1990; one was in the area of synthesis of large mammal activities, three involved modeling animal population dynamics, one concerned restoration of native animals and removal of exotic animals from park areas, and two dealt with the role of diseases and parasites.

As AD/NR Eugene Hester noted in his October 11, 1990 memorandum to the field, the FY90 effort was "a well-conceived, though modest, program," whose success was due in part to the early involvement of the Regions. Dr. Hester had framed his 1989 Call for Preproposals as a response to comments of the Regional Chief Scientists regarding increasing the involvement of Service personnel in carrying out the purposes of the Natural Resources Special Initiatives program. "I welcome this involvement," he said at the time.

In an October 11, 1990 follow-up, Dr. Hester has informed the Regional Directors that he would like to continue the program in FY 1991. He notes that the FY90 program "complemented our overall Natural Resource Preservation Program (NRPP) project list and related closely to the major Servicewide issues we have identified through the Natural Resources Assessment and Action Program and other mechanisms," and solicits pre-proposals for specific projects in the following categories:

1. Effects of Urbanization and/or Boundary Development on Park Environments;
2. Management of Animal Populations;
3. Managing Human-Natural Resource Conflicts and Issues; and
4. Other proposals that address Servicewide natural resource policy issues, especially those that are interdisciplinary and multi-regional in scope.

Pre-proposals were due to the AD/NR by December 14, 1990. January 11, 199l is the date set for issuance of the invitation for proposals. Proposal deadline is February 22; award decisions are slated for March 15, and funds will be transferred on March 29, 1991.

Park Science will be reporting on the seven projects funded in FY90 as results become known.

In the Pacific Northwest Region, the three funded projects are (1) a synthesis of activities and issues related to wildlife management in the National Parks; (2) development of a conceptual model to provide guidance for the management and regulation of animal species in the National Parks, and (3) animal disease issues in the National Park System.

The other four projects funded in FY90 are:

Midwest Region, population management of white-tailed deer in relation to spatial attributes of Midwestern NP areas; Southwest Region, landscape structure and its impact on interpretation of desert mule deer population; North Atlantic Region, arthropod-borne diseases in and near national parks, national seashores, national lakeshores, and national rivers in the continental US; and in the Western Region, restoration of native animals and removal of exotic animals in NP areas.

mab notes

Televisio de Catalunya in Barcelona, Spain is planning a 13-part series called **Biosphere**, to be filmed in biosphere reserves (BRs) around the world. Each 1-hour program will focus on a different biome, using BRs as representative areas of that biome. Altogether BRs from about 20 countries will be featured. The programs will describe each biome's natural condition, its use by people, and its environmental problems, as well as research and education in the representative BRs. Bill Gregg, NPS MAB Coorinator, calls the project "the biggest boost yet for the MAB program." Olympic NP, the Southern Appalachians, and the Noatak National Preserve, representing, respectively, temperate rainforests, temperate broadleaf forests, and tundra communities, are being considered as proposed filming sites. The filming will take place in 1991 and early 1992, for showing in Spain in late 1992.

This ambitious project, expected to cost $2.2 million for the Spanish version alone, does not end there. Sponsorship is being sought for translation and use in many other countries, and UNESCO-MAB has agreed to assist with worldwide distribution. Coffee-table book versions are planned. Also being considered are interactive videos for use in visitor centers and other such places, and widescreen (I-MAX) film versions. The director of operations of Televisio de Catalunya came through the NPS Washington office in June 1990. Bill Gregg assisted her with planning and other meetings in Washington, which included the Smithsonian Institution, the Discovery TV channel, and public television.

Biosphere was conceived by Ramon Folch, Secretary of the Spanish MAB committee and producer at Televisio de Catalunya. This project follows a highly successful series by this TV station on the Mediterranean basin, showing environments and their human use.

Meeting at Hog Island, VA, Oct. 10-12, 1990, the newly constituted **MAB Biosphere Reserve Committee** began development of an action plan for U.S. BRs. Discussion focused on the mission, statement, goals, and a number of proposed action items.

The October 1990 issue of the ***U.S. MAB Bulletin*** announced the **U.S. MAB grants for FY 1990**. Among these is the first funded project to be directorate-proposed and carried out by its members to pursue research on the major program area of the directorate. This $300,000 grant will support the first 2 years of a comparative study by the Temperate Ecosystems Directorate of the effects of surrounding land ownership patterns on the biological diversity and socioeconomic viability of managed and protected land in the Olympic Peninsula and the Southern Appalachians.

One of the principal hypotheses to be tested is that the large blocks of managed privately and publicly owned forest land on the Olympic Peninsula have resulted in landscapes with less ecological connectivity, habitat abundance, and resource stability than the intermixed, comparatively small blocks of public and private land in the Southern Appalachian region.

Another grant of special interest to NPS readers is one for a study of the use of marine harvest refugia as fishery management tools in the Channel Islands NP and BR area (Gary Davis, principal investigator).

The **Mammoth Cave Area Biosphere Reserve** was dedicated Sept. 26, 1990. This event should further strengthen mutual ties between the national park and surrounding lands, the quality of whose surface and subterranean water is so critical for park health. The ceremony was held in conjunction with the Eastern/Southern Regional Heritage Conference of The Nature Conservancy, with Judge David Martin representing the Barren River Area Development district – co-sponsor of the BR nomination, Bob Baker, NPS Southeast Regional Director, and others involved in the BR program. The BR includes Mammoth Cave NP as the core area and the park's 82,000-acre groundwater recharge basin as the transition zone.

A **plenary session on biosphere reserves** was held Oct. 18, 1990, at the symposium on Natural Areas and Yosemite: Prospects for the Future. Bill Gregg, who gave the introductory presentation, reports that a diverse audience of some 250 people showed considerable interest in the BR program. Discussions included the emerging leadership role of California (which now has 8 BRs) in the BR program, and the possibility of establishing a Sierran BR, where a good dialogue already exists between the major public land managers – the NPS and the USFS.

The Government Printing Office (GPO) has made a modest concession on the price of the international **brochure on biosphere reserves**. The price per 100 copies now is $225. Single copies still cost $3. Called ***Biosphere Reserves***, the brochure may be obtained from: GPO Bookstore, 710 North Capitol St., Washington, DC 20401; (202) 783-3238. New stock number: 044-000-02277. Small numbers of copies of the first edition, which differs only in the omission of about a dozen BRs from the map and list, and a different numbering system for the BR list, can be obtained free from David Figlio, Wildlife and Vegetation Division, NPS, PO Box 37127, Washington, DC 20013-7127; (202) 343-8135.

Napier Shelton
NPS Washington Office

Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned

By David W. Lime and John F. Karish

Should a carrying capacity (or some form of recreation use limitation) be place on recreational boating on the Upper Delaware Scenic and Recreational River?

The answer **NO** is the conclusion from research conducted on the river since the late 1970s – especially research initiated since 1984.

As recreational use of America's outdoor resources grew rapidly during the 1950s and 1960s, planners and managers struggled to find answers to questions about "how much use is too much" and "How can overuse be controlled." Conventional wisdom called for action to manage the numbers of visitors, limit use during certain times or at specified locations, or increased capacity of park lands or facilities to accommodate more people.

In spite of the dubious definitions of carrying capacity and the frequent cautions and limitations presented for its application, many managers tacitly assumed that if we could just come up with the maximum **number** of people to let use an area at any one time, their problems would be solved! *the move was on to find a magic number that would answer the troublesome questions: How much use is too much?

Management Objectives

Actually, recreational carrying capacity is a management concept – a way of thinking about recreational use problems and how to manage a particular resource. The basic thrust of such a framework must be grounded in the understanding that appropriate use determinations can only be applied in light of specific management objectives. Once objectives are established, indicators and standards can be identified and compared with on-the-ground conditions.

Despite many failures to establish recreational carrying capacities, the concept does have merit when one recognizes the complexity associated with establishing such capacities, and then begins to look at such capacities within the framework of specific, measurable, and attainable management objectives. Identification of the types of conditions desired for an area can provide the basis for planning and management that will lead in the desired direction.

Table 1. Studies of Appropriate River Recreation Use, Upper Delaware Scenic and Recreational River: Summary of Selected Conclusions Regarding the Limitation of Recreational Boating on the River

Topic/Issue Studied	Use Limits Recommended?	Selected Major Issues Noted in Studies
		ECOLOGICAL STUDIES
Site impacts at campsites & stops	No	• Litter, human waste, soil & vegetation damage • Many impacted sites on river • Impact to individual sites often covers a large area
Wildlife impacts	No	• Potential disturbance of wildlife by visitors • Potential overfishing at some locations
		RECREATION VISITOR STUDIES
Boaters & floaters	No	• Diverse but relatively minor problems – many beyond management control • Alcohol consumption • Lack of information about available routes, facilities • Lack of facilities (toilets, drinking water, phones) • Only a few visitors felt crowded • Conflict within social groups of visitors
Tourism in general	No	• Boater safety • Lack of toilets, litter receptacles • Lack of information about river access & facilities
		SOCIO-ECONOMIC STUDIES
Landowners	No	• Trespass by visitors on private land (potential property damage) • Protecting owners' privacy • Litter • Future regulations on uses of land in river corridor
Outfitters	No	• Low water levels • Water pollution • Lack of clear jurisdiction • Alcohol consumption • Lack of facilities (toilets, drinking water, phones) • Need for information & education of visitors • River safety
River communities	No	• Trespass by visitors on private property • Lack of education & information for visitors • Lack of facilities (rest stops, drinking water, toilets)
		MANAGERIAL STUDIES
Legislative intent	No	• Legal to limit use; directives not explicit

NOTE: *The conclusions presented in the table include research conducted as part of the NPS cooperative studies as well as other research on the Upper Delaware in the past 10 years related to the topic.*

Research on the Upper Delaware

Recognizing the fundamental importance of management objectives, the emphasis of the Upper Delaware research program was switched very early away from the term "carrying capacity." Instead, it focused on information gathering, to aid resource managers and citizen advisory groups in setting proper management objectives and determining what an appropriate river recreation use should be on this particular river (Lime et al. 1985). Although limiting use might become an acceptable and needed management action, the importance of managing **numbers** of visitors as a primary product of the research was de-emphasized.

The cooperative research effort was built upon existing information and intensive discussion about how to define appropriate use on the Upper Delaware. Research was to deal with those persons and groups involved in influencing management directions for the river – the managers, the users, the commercial sector, and inhabitants of the region, including interest groups and riparian landowners.

Thirteen separate studies were conducted in the past 6 years, involving the Park Service, the Forest Service, and university scientists nationwide. Research was grouped into 4 major subject components: (1) The environment and impacts resulting from recreation use; (2) The nature of the users and their recreation experiences; (3) The social and economic aspects of the region impacted by recreational river use, and (4) The management system involved in overseeing and protecting the resource.

Boating Limitation – Is There a Need?

The consensus from the research is that the levels of boating and recreational conflict, as well as other problems associated with visitor use on the Upper Delaware, are not severe enough or of a nature to warrant use limit policies now.

In general, factors other than number of visitors, per se, are more useful in defining appropriate and acceptable recreational use on the river. Table 1 summarizes these findings and shows there was greater concern about many other issues such as litter, disposal of human waste, trespass on private land, overconsumption of alcohol, lack of or inadequate facilities, trip planning and interpretive information for visitors, and within-group conflicts.

Few, if any, of these problems can be solved simply by limiting numbers of visitors. For example, reducing numbers of visitors alone would not solve the concern for excessive consumption of alcoholic beverages by river floaters. Visitor education, banning alcohol on the river, or increasing law enforcement might be a more direct and effective solution and actually might lead to increased visitation and fewer conflicts.

Reducing use also would not remedy most visitor-induced impacts to river campsites and other stopping places. Marion and Cole (1987) and Marion (1988), in addressing issues of ecological impact on recreation sites, found that trespass on private land in the river corridor was a widespread problem with resulting impacts. They showed that the amount of visitor use is not a good predictor of bio-physical impact on sites, because even limited use causes significant site

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***No limit to the fun** for Upper Delaware river recreationists.*

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damage. Educational efforts to improve visitors' knowledge and skills of minimum impact techniques seemingly would have a more positive influence on site impacts.

Among others, Knopf, Graefe, and Schreyer (1988) studied river visitors to determine the character of desired recreation experiences. Most visitors were well satisfied with their outing, and few reported that there were too many people on the river. Rather, many of the reasons visitors gave as detractors to their experiences dealt such relatively minor topics as weather and lack of toilet and drinking water facilities between access points.

Studies by Carroll, Twight, and McCabe (1987) report the history of federal presence in the river corridor and the problems in communication that led to many of the conflicts about appropriate river recreation use. Their analysis mentions the role of visitor education and information as well as provision of stopping places along the river in helping manage the problems of trespass on private lands, with resultant recreation-related conflict.

Limiting Is Legal, BUT ...

Research by Simpson and McAvoy (1987) explored the legislative and legal foundations for establishing carrying capacity on the Upper Delaware. Legislative intent calls for general preservation to maintain conditions and values that existed at the time of river designation. Management guidance is offered by requiring that carrying capacity be reviewed on a 5-year basis to determine if overuse is occurring. If so, appropriate steps to reverse the environmental damage must be taken. In really, the legislation does not give explicit direction on limiting recreational use nor does it rule out establishing carrying capacitites and developing strategies to limit use. No specific methods of implementation are identified or recommended.

Research to date points away from an aggressive effort to set limits on recreational boating on the Upper Delaware – at least based on current recreational use levels, observed impacts, and guidance from a variety of interest groups. The majority of the river user groups are satisfied with current conditions, and limiting use would seem, by itself, a poor solution to existing problems.

Where Do We Go From Here?

Most of the apparent problems seem not to be problems of numbers of people or boats. They are problems related to human behavior. These problems call for a variety of actions, including improved communication among people and groups, more effective law enforcement, a greater number or more appropriately located facilities or visitor services, and improved education for visitors in trip planning, appropriate river etiquette, and outdoor skills.

Partnerships to develop and implement such actions between the NPS and the various groups and persons interested in river issues could enhance the long-term health and vitality of the Upper Delaware as a quality scenic and recreational resource.

Lime is a research associate at U/Minn's Dept. of Forest Resources, St. Paul and Unit Leader of the NPS/CPSU at U/Minn. Karish is Chief Scientists, NPS Mid-Atlantic Region, Philadelphia, PA.

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Park Science, A Resource Ma...

PARK SCIENCE
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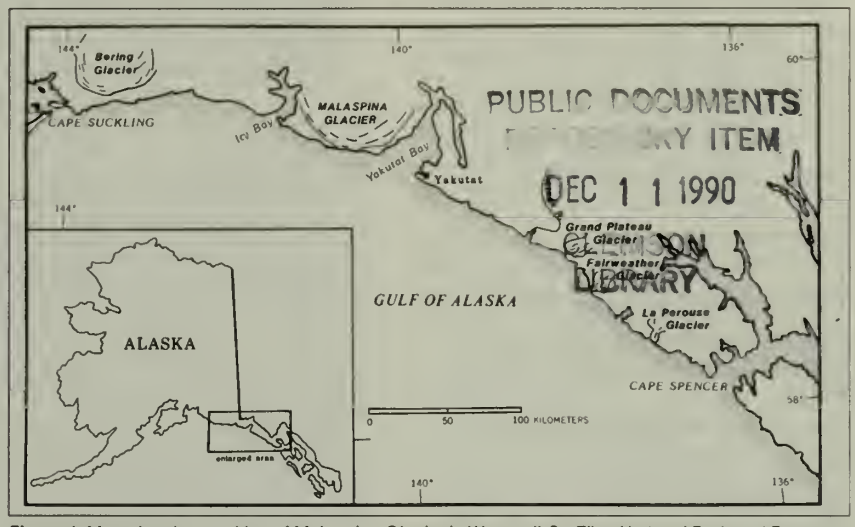
Malaspina Glacier Research Holds Clues To Possible Global Change Scenarios

By Bruce F. Molnia and John E. Jones

The Malaspina Glacier is the largest glacier in Wrangell-St. Elias National Park and Preserve *(Figure 1)*. The glacier, with an area of more than 2,650 km², is covered by a complex system of folded moraines, the result of differences in flow rate and volume between the Malaspina's tributaries. In its lower reaches, the glacier forms a broad, bulbous, gently-sloping, piedmont lobe. The lobe, which covers an area of more than 1,500 km² is the site of an ongoing investigation by the U.S. Geological Survey (USGS), combining field observations and measurements with laboratory analysis of digital remotely sensed data.

Although the USGS has actively investigated the Malaspina Glacier and its surrounding area since the time of I.C. Russell in the 1880s, it was the November 1986 acquisition by the USGS of digital side-looking airborne radar (SLAR) data of the Malaspina Glacier *(Figure 2)* that resulted in the present study. The investigation has two themes: (1) the use of radar remote-sensing to provide information about the characteristics of the bedrock underlying Malaspina Glacier and the relationship of the bedrock to the glacier's surface features, and (2) the use of radar to provide information about the history of the glacier.

Continued on page 3



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Figure 1. Map showing position of Malaspina Glacier in Wrangell-St. Elias National Park and Preserve.



PARK SCIENCE

NATIONAL PARK SERVICE

FALL 1990

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

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Editorial:

Conflicting headlines scream at one another across the pages of newspapers; on radio and TV deep baritone voices, warning of impending climatic crises, compete with unctuous assurances that "nothing out of the ordinary" is going on in the global climate department. Robert C. Cowen, who writes a "research notebook" column for ***The Christian Science Monitor***, examines the entire range of disputatious dialogue and winds up with this observation:

"None of this means we can ignore man-made global warming. Human activity already has added around 2.2 watts per square meter to the atmosphere's natural greenhouse heat-trapping of 151 watts per square meter of Earth's surface averaged over the entire planet and for a full year. There's little dispute about that.

"The annoying fact is that nobody yet can determine whether this has begun to raise the global temperature or merely is expressed in other effects such as undetected changes of cloudiness or ocean circulation."

Which brings Earth's human passenger complement face to face with a mathematical concept known as "type 1 – type 2 errors." A Type 1 error assumes the proposition is false when it may in fact be true. A Type 2 error assumes the proposition is true when in fact it is false. In the Type 1 error, you do nothing, assuming that no problem exists and you suffer the consequences. In the Type 2 error, you mount an effort to meet the possible problem and then it turns out there was no problem.

An examination of this concept allows us, as the deciders and also the victims of whichever error we elect to make, to examine the consequences of both errors. In the case of global climate change, we can elect the Type 1 error: Do nothing, and be unprepared in case of sea level rise, drastic alterations in whole ecosystems, fresh water shortages, entrapment of plant and animal species with no migratory corridors or plans for relocation, and so forth, all the while continuing the human behavior that may be exacerbating climate change.

Or we can elect the Type 2 error: Mount a program designed to avert global warming, engage in massive forestation and reforestation, and above all begin a globally integrated monitoring of earth, air, and water, flora and fauna, that will give us first a baseline set of data, and then a "moving picture" of how this data set is altering – where, in what directions, and how fast.

It should be obvious that the measures appropriate to the Type 2 "error" will be useful whether or not the Earth is heating up. The kinds of information such attention to the global condition will give us will be of immeasurable benefit in ANY event. It is not as though we were preparing for some terrible possibility that, if it fails to materialize, will make of all our preparations only wasted effort. The resources we spend preparing for *this* kind of threat can only add to our store of useful knowledge and help us sail into the future in a tighter, more manageable ship.

It is noteworthy that in this attempt to heal the earth many government agencies are joining hands with one another, with non-governmental entities, and with groups representing the world beyond our political borders. This summer, for instance, singer John Denver was instrumental in setting up the Aspen Institute for Global Change, co-sponsored by the Amway Corporation, the UN Environmental Program, and the National Aeronautics and Space Administration. Saving the environment, said Denver at a July 26 news conference, "is the most important task that faces the human race at this time."

Obviously Denver, Amway, the UN, and NASA have all opted to make only Type 2 errors.

The National Park Service has tailored its role in global change monitoring and research so that it fits neatly into the pattern of the national and international effort. Included in this issue is a pull-out section that presents the overall context within which the tasks will be performed and the money to do them will be allocated.

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Investigations of the Malaspina Glacier, Wrangell-St. Elias National Park and Preserve

Continued from page 1

SLAR is an electronic imaging system that has been used on a worldwide basis by the earth science community, most commonly in petroleum and mineral exploration, sea ice studies, and hydrologic investigations. SLAR data are acquired by an aircraft transmitting a radar beam perpendicular to its flight line. SLAR uses an active sensor, supplying its own source of microwave energy, allowing SLAR data to be acquired either day or night and through most cloud cover. The beam is both reflected and scattered by the ground surface and man-made objects. Energy that is bounced back (backscattered) to the aircraft's receiving antenna is recorded to produce an obliquely illuminated view of the ground, which depicts subtle aspects of surface texture, topography, roughness, slope, and wetness, and the intrinsic electrical properties of materials at or near the surface. SLAR data of the Malaspina Glacier are X-band with a wavelength of about 3.2 cm. The data were collected with a synthetic aperture radar (SAR) system and were polarized to enhance subtle horizontal features such as moraines and crevasse zones. SAR is a radar data storage and processing technology that results in improved resolution.

This study represents one of the first uses of SLAR in investigations of arctic and subarctic glaciers. The 1986 data were the first digitally acquired, airborne radar of coastal, southcentral Alaska and the Malaspina Glacier. The data showed unexpected backscatter responses from the surface of the Malaspina Glacier. Specifically, the radar imagery showed three types of features (glacial-like valleys, dendritic valleys, and an arcuate linear), that were unfamiliar to researchers working with the glacier.

Prior to field investigation of these surface backscatter features, our interpretation was that the features were real, and represented topographic differences on the glacier's surface that mimicked the morphology and relief of the bedrock that underlay Malaspina Glacier. Seismic and gravity investigations, performed in the early 1950s, determined that the ice thickness of the southeastern part of the piedmont lobe was between 500 and 1,000 m and that the bottom of the glacier extended below sea level. However, the details of the morphology of the bedrock basin underlying the glacier were unknown.

Because X-band radar doesn't penetrate more than a few centimeters of snow and ice, we reasoned that the unusual features described here were not the result of the radar "seeing through the ice," rather, they had to be surfacial in nature. Consequently, we concluded that in spite of Malaspina Glacier's great ice thickness, there was some direct relationship between ice-surface morphology and underlying bedrock morphology. Understanding this relationship might help in understanding the recent and long-term histories of the Malaspina Glacier and provide insights as to how the glacier might respond to a changing environment.

As observed on X-band SLAR imagery, the three types of features have the following characteristics: GLACIER-LIKE VALLEYS are 10 to 25 km in length and about 1.5 to 2.5 km in width. These valleys are parallel or subparallel to ice flow directions. Cirque-like features, adjacent to some of the glacier-like valleys are less than 1 km across, have abrupt changes in backscatter response across their boundaries, and have rounded amphitheater-like geometries. DENDRITIC VALLEYS are oblique to ice flow directions, are 6 to 12 km in length, and 0.5 to 1.0 km in width. At least 5 distinct east-west trending valleys are present. AN ARCUATE LINEAMENT, a gently curving linear feature that extends in an east-west direction for more than 65 km can be followed from the shoreline of Icy Bay, across outwash sediments and the upperpart of the Malaspina Glacier, to Malaspina Lake. The trace of the lineament may correspond to the trace of the Fairweather Fault or a related boundary fault between the North American and Pacific Plates.

> The Malaspina Glacier is the largest glacier in North America and one of the largest outside the icecap regions of the world. The Malaspina Glacier was designated a National Natural Landmark on August 14, 1970. It was determined to be of national significance because of its scientific value.

Field investigations were conducted in 1988 and 1989 to "ground truth" the radar backscatter features. Specifically, investigations were conducted to determine: (1) glacier ice thickness; (2) depth to and configuration of bedrock underlying the glacier; and (3) the relationship of surface backscatter features to surface features and underlying, subglacial-bedrock morphology.

In 1988, field investigations examine the topographic relief, slope characteristics, and other surface conditions of regions of the glacier producing the three types of unusual radar backscatter features. Field work was performed in September to maximize the percent of the glacier's surface that would be snow free. The three features correspond to areas of the surface that are as much as 40 m lower than adjacent areas and are characterized by significantly fewer crevasses, minimal surface relief, a veneer of sediment, and substantially more standing and running water on their surfaces. The lows are generally areas of smooth and featureless ice and appear to be areas of compressional ice flow, while the highs are areas of fractured and broken ice and appear to be areas of extensional ice flow. The ice-surface characteristics in the topographic lows would tend to attenuate or dissipate a radar signal; the result would be a weak backscatter response expressed as a dark feature on radar imagery. The topographically higher ice, adjacent to the lows, with its irregular surface, had numerous "corner reflectors", or surfaces that would provide a strong reflection of the radar signal back to the antenna. Hence, these areas have a strong backscatter and a bright appearance on radar imagery.

Ice-penetrating radar investigations conducted in September 1989 concentrated on determining the thickness of Malaspina Glacier's ice at more than 50 locations. Unlike SLAR, ice-penetrating radar, due to its much longer wavelength (many meters), can measure the depth to bedrock through a kilometer or more of ice. The maximum ice thickness measured at Malaspina Glacier exceeded 850 m, whereas the minimum was only about 150 m. Comparison of ice thickness measurements and ice surface elevations at each site suggests that the Malaspina Glacier occupies a deep basin or series of basins extending well below sea level, and that the southern limit of the glacier coincides with a large moraine complex that occupies part of the basin system. A belt of this moraine is exposed above sea level for more than 10 km at Sitkagi Bluffs and forms the rocky coastal beach that separates the glacier from the Gulf of Alaska. The basin complex underlying the Malaspina Glacier is the product of glacial erosion during a series of advance and retreat cycles extending back into the Pleistocene.

Ice thickness and elevation measurements indicate that at almost every site the base of Malaspina Glacier extends below sea level and that the ice thins significant in the vicinity of the Sitkagi Bluffs moraine. Northeast of Sitkagi Bluffs, an ice thickness of about 175 m was measured with a basal depth only about 10 m below sea level. By comparison, at Samovar Hills,

Continued on page 4



USGS Earth Scientists, *Tom Taylor (right), and Bill Schoonmaker, are seen here performing field measurements on Malaspina Glacier.*

Malaspina Glacier

(Continued from page 3)

approximately 50 km north of the southern limit of the Malaspina Glacier, a basin extending more than 250 m below sea level is occupied by about 860 m of ice. The maximum measured depth of the base of the ice below sea level is about 320 m.

Two measurements were made adjacent to Malaspina Lake along the southeast side of the glacier. One detected an ice thickness of about 180 m of ice extending about 75 m below sea level, and the other showed an ice thickness of about 145 m extending about 130 m below sea level.

The measurements at Malaspina Lake and Samovar Hills are very important with respect to the past and future history of the glacier. If, as a result of sea level rise, climatic warming, or coastal erosion, a portion, or all of the terminus of Malaspina Glacier were to be exposed to Gulf of Alaska marine waters, it is possible that the glacier would become an actively calving, rapidly retreating, tidewater glacier. Elsewhere, where rapid tidewater glacier retreat has occurred, such as at the Icy Bay segment of Wrangell-St. Elias National Park, Glacier Bay National Park, and Kenai Fiords National Park, fiords as long as 100 km have been exposed. At the site of the Samovar Hills measurement, even compensating for isostatic rebound, the water depth following glacier retreat would be about 125 m.

A detailed ice-penetrating radar survey with 100-m-spaced soundings was made in the southcentral part of the glacier, an area where radar backscatter features had previously been interpreted to suggest a relationship between ice surface features and underlying bedrock morphology. One transect across a surface low (channel) and its adjacent high found that whereas surface elevations only differed by about 20 m, the thickness of the ice in the area of the high was about 390 m compared to about 590 m in the adjacent low, or 200 m thicker. These data support the described relationship between surface morphology, backscatter features, and bedrock morphology.

Offshore of the Malaspina Glacier, marine seismic data document a series of sediment filled valleys cutting across the continental shelf. When projected under the large terminal moraine, the sea valleys appear to link with the glacier-valley like features seen on the SLAR data.

Several image processing and geographic information systems continue to be used in digital image analysis of the features described here. Additionally, radar data of the Alaskan coastal area from Icy Bay to Grand Plateau Glacier and for much of the southern half of Wrangell –St. Elias NP have been transferred to several CD-ROM disks that also contain public domain image processing software released by USGS and the National Space and Aeronautics Administration.

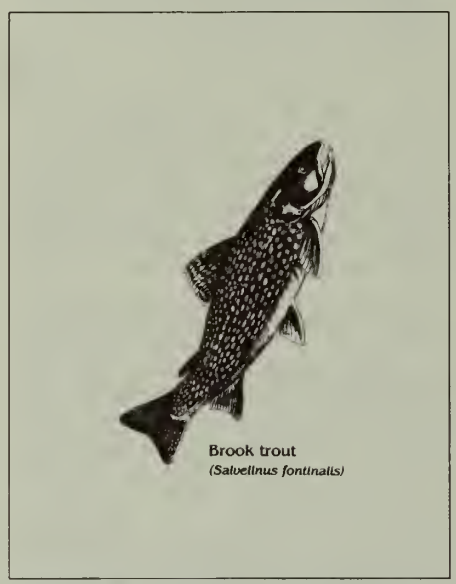
Field work, including additional ice-penetrating radar studies planned for 1990 through 1993, will continue to carefully measure ice thicknesses and the bedrock morphology underlying Malaspina Glacier and several other glaciers in southern Alaska. With these data in hand, we will have a much more complete understanding of the relationship between ice surface morphology and the topography and morphology of the underlying bedrock. We will also have a much better understanding of the ability of SLAR to provide information about the past and future histories of the Malaspina Glacier system.

Molnia and Jones are research scientists wtih the U.S. Geological Survey at Reston, VA 22092.

Native Brook Trout Restoration at Great Smokies

Distribution of native brook trout *(Salvelinus fontinalis)* in the Southeast has undergone major shrinkage since 1900 (Seehorn, 1978). One of the best documentations of this decline is in Great Smoky Mountains NP (GRSM), and an excellent, detailed report of attempts there to eradicate the non-native rainbow trout from native brook trout streams appears in the ***Proceedings*** of the Wild Trout IV Symposium held at Yellowstone NP Sept. 18-19, 1989.

The paper, by Stephen E. Moore and Gary L. Larson, describes how, prior to establishment of the park in 1936, the area was extensively logged and brook trout disappeared from downstream segments of many streams in logged watersheds (Powers 1929). Rainbow trout *(Oncorhynchus mykiss)* were introduced into these stream segments and into other streams inhabited by brook trout beginning about 1910



***Vern Hippensteal's** artwork, from* Protecting Biological Diversity in the National Parks *(see mention in Southeast Regional Highlights).*

(King 1937). Park management later supplemented these stockings from rearing facilities in the park to provide recreational angling.

The general view was that brook trout would recover its former range as the forests recovered. But early work by King (1937) suggested that rainbow trout populations were expanding into brook trout waters, thereby further reducing the distribution of brook trout. Although surveys in the 1950s (Lennon 1967) did not show much change in brook trout distribution relative to King's initial observations, later surveys by Jones (1978) and Kelly et al. (1980) clearly demonstrated a substantial decline.

The gravity of the problem prompted NPS to initiate a series of studies between 1975 and 1981 to evaluate rainbow trout encroachment into brook trout streams and to determine the feasibility of eradicating rainbow trout from selected isolated streams, using the backpack electrofishing technique. Moore's and Larson's paper summarizes the results of these studies and reports on a recent investigation that evaluated success of the restoration program.

Although the encroachment process is difficult to document due to complex and dynamic abiotic and biotic interactions, and although the mechanisms are poorly understood, (Larson and Moore, 1985) the results of the extensive testing described in the article seem to demonstrate clearly that rainbow trout have a negative effect on native brook trout.

Initial restoration work by Moore et al. (1983, 1986) did not appear to eradicate rainbow trout. These results did show that the density of adult rainbow trout was reduced to less than 1/100 m2 in one field trip (consisting of 3 electrofishing passes) in some streams, but additional effort was required in others. This variation in success was due to the complexity of the stream channels, which affected the efficiency of the electrofishing. Nonetheless, the results indicate the backpack electrofishing technique can be used to control density of rainbow trout. In fact, eradication is feasible in small streams.

Reclamation by electrofishing is labor-intensive and time-consuming (Moore et al. 1983). A 2-person crew expends about 1-person day fishing a 100-m section of stream 3 times. Use of large crews and multiple shocking units increases capture rate, but does not appear to reduce labor costs. (Larson et al. 1986).

The experience Moore and Larson report with the backpack electrofishing technique suggests that several precautions should be considered before undertaking a restoration project. First, streams must be on an appropriate size to make the effort worthwhile. If large streams are targeted for restoration then other techniques should be explored. Second, the project should be adequately funded because several years of effort may be required to control non-native fish populations. Third, the targeted restoration area should be upstream from a known barrier to fish immigration, otherwise non-native fish may immigrate upstream into the restored section.

Moore is a fisheries biologist at Great Smoky Mountains NP; Larson is an aquatic ecologist with the NPS/CPSU at Oregon State University.

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Surveys of National Park Experiences by the Visitor Services Project

By Dana Dolsen

The Visitor Services Project (VSP) conducts surveys to gather information about visitors and visitor services that park managers can easily use. At least three kinds of sociological information are useful to park managers. The first is knowledge about the kinds of services, activities and opportunities available to the public. The second is knowledge about the visitors: who they are, where they go, what they do, and so forth. The third is understanding the relationship between services and visitors; i.e., are visitor needs being met in the most efficient way, while protecting resources?

The VSP is based at the University of Idaho's Cooperative Park Studies Unit (UI/CPSU) in Moscow, Idaho. The VSP's technical development began with pilot studies in 1982. Figure 1 shows that by the end of 1990, 37 visitor studies will be completed in 34 parks. In 1988 the VSP was incorporated into NPS Operations. Currently two NPS employees are stationed at the UI/CPSU: Margaret Littlejohn is western coordinator, Dwight Madison is eastern coordinator.

The Chief of Interpretation, Washington Office (WASO), holds VSP administrative responsibility. VSP study funding comes from the park being studied, regional offices, and WASO. The VSP has an advisory committee; its membership provides Service-wide guidance from parks, regional offices, and Service Centers. The committee meets annually, recommends parks for studies from regional nominations, guides VSP development, and approves special projects.

Study Process and Methods

Figure 2 presents the VSP study process. After a park's selection, VSP personnel hold an on-site questionnaire design workshop to determine the park's information needs about its visitors. In the field a trained team contacts visitors, conducts interviews, and distributes mail-back questionnaires. Completed questionnaires are received at the UI/CPSU; data definition, input, verification, and analysis are completed. A draft report is prepared, reviewed by park staff, and revised by the VSP. A results workshop on how the data can be used is held for each park's staff. Sometimes a separate session is held for local media, the chamber of commerce, and others. The final report is then printed and made available from the superintendent. For the next six months, upon request, additional data analyses are provided to the park at no additional cost. In 1989, the average cost to parks was approximately ten thousand dollars.

VSP visitor studies are based on a systematic sample of park visitors during a specific week chosen by park staff. The sample is usually stratified by entrance or zone, depending on park characteristics. Sample size is based upon past visitor statistics, with a minimum accuracy of ±4 percent for simple dichotomous variables at the .05 level. The VSP and park staffs jointly formulate the appropriate questions, which must then be approved by the Office of Management and Budget (OMB). A core unit of standardized questions is in most VSP studies (i.e., demographics, use of routes/sites, activities, and general comments); OMB approval of these is commonplace. New questions on unique park issues need specific OMB clearance.

As visitors enter the area, interviews are conducted to distribute the mail-back questionnaire, collect data

1982	1983	1984	1985	1986	1987	1988	1989	1990
	Development Studies			Operational Studies				Studies Underway
Grand Teton	Yellowstone	Glacier	Crater Lake	Gettys-burg	Harpers Ferry	Craters of the Moon	Ever-glades	Death Valley
	Mt. Rushmore				Grand Teton		Statue of Liberty	Glacier
								White Sands
			North Cascades	Indepen-dence	Yellow-stone	Bryce Canyon	Delaware Water Gap	Kenai Fjords
								John Day Fossil Beds
				Valley Forge	Mesa Verde	Glen Canyon	Lincoln Home	Canyonlands
								National Capitol Region-Mall
					Indepen-dence	Denali	Yellow-stone	Petersburg
								Gateway
					Colonial		Muir Woods	Scotts Bluff/ Agate Fossil Beds
					Shenandoah		White House	

Figure 1: VISITOR SERVICES PROJECT 1982-90

Figure 1. *Visitor Services Project 1982-90.*

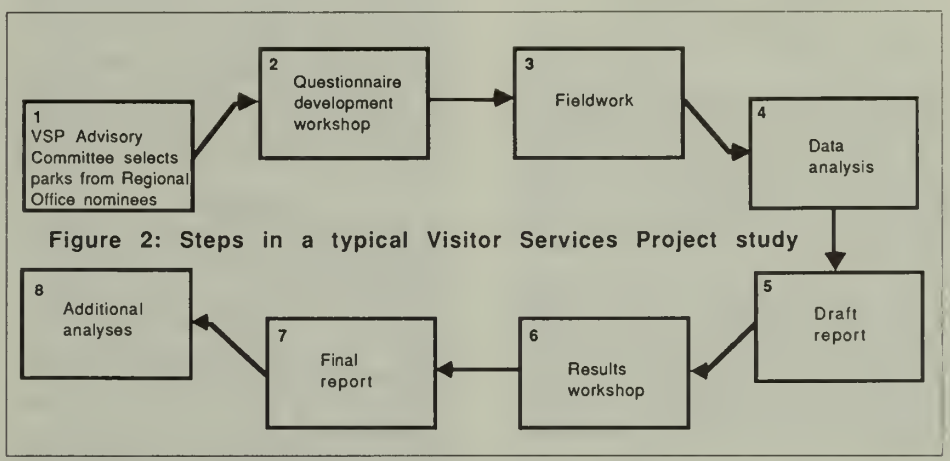


Figure 2: Steps in a typical Visitor Services Project study

Figure 2. *Steps in a typical Visitor Services Project study.*

for response bias checks, and gain mailing addresses for follow-ups. The 11 studies conducted in 1988-89 have averaged an 81 percent response rate. Response bias checks on key demographic variables are conducted; the data are converted into graphic displays. Charts and figures with low sample sizes are identified with cautions for managers to consider. Open-ended questions are content-analyzed and organized into tables, and the actual comments included in a separate appendix to the final report.

The surveys have several limitations, described in each final report. Responses to mail-back questionnaires may not always reflect actual behavior. The results cannot be generalized beyond the study period. Visitor groups that do not include an English-speaking person may be under-represented.

Following are examples of what parks learned from visitors about services and facilities offered, plus visitor opinions on topics of interest to park managers.

STUDY RESULTS, MANAGEMENT IMPLICATIONS

Interpretation

Managers question whether interpretive programs meet real needs. Do they effect changes in visitor awareness, attitudes, or even behavior? Tour managers at the White House may question whether separate tour needs for programs and services exist by comparing their Congressional and public tour results. For example, public tour visitor groups used the map/brochure twice as much as did Congressional tour visitor groups (see Figure 3). To ensure its continued use and usefulness for each tour, a detailed evaluation may be desired.

Concessions

Park managers question how useful and important particular services or facilities are to visitors; VSP surveys can provide such data. A park can then evaluate a company and the need for a product or service.

Managers at the Statue of Liberty NM measured visitor use of several concession services/facilities, as well as their quality ratings. Figure 4 shows that visitor opinions varied on the quality of the restaurant. Potentially, a variety of alternatives to improve quality may be considered.

Maintenance

Increasingly diverse park visitors demand a range of accessible, quality facilities. Visitors frequently criticize trash build-up or a lack of upkeep at park sites. By seeking and listening to visitors' views, managers can improve facility maintenance programs, thus providing clean and well-maintained settings for quality experiences.

Continued on page 6

Visitor Services *(Cont. from p. 5)*

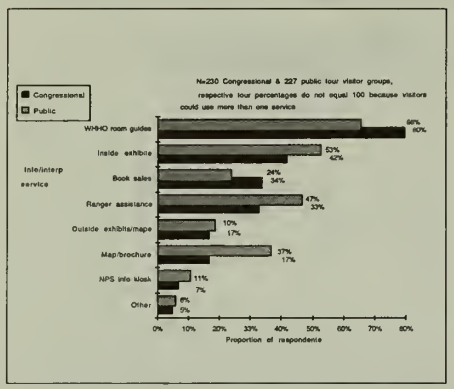


Figure 3. Congressional and public tour use of White House interpretive/information services, Summer, 1989.

For example, Muir Woods NM's trails are congested in the summer. Managers could schedule maintenance personnel on popular trails according to the proportion of visitors (see Map 1), peak hours, or busiest days.

Resource Management

Determining ecologically appropriate and socially acceptable levels of intervention in natural processes is a constant challenge and struggle for land management agencies. The NPS is learning that people do not have a basic understanding of natural phenomena, which in turn affects the acceptance of resource management policies. Land managers may gain policy insights for the future by assessing visitors' perceptions of natural and man-made phenomena and their impacts.

For example, Yellowstone NP visitors were asked if the 1988 fires were beneficial to Yellowstone's natural systems (plants, animals, soil, water, etc.). Figure 5 shows that 48 percent of visitors thought fire benefitted Yellowstone's ecosystem. Such results could help all land management agencies make more informed policy decisions.

OTHER PROJECT UPDATES

Projects underway include: a report on 1982-90 VSP progress – *A Diversity of Visitors*, a VSP training manual, an OMB report on survey follow-up methods, and several journal articles. The Pacific Northwest Regional Office funded a 1989 VSP database development to profile NPS visitors; data may be available from approximately 20 park studies by the end of 1990.

FUTURE DIRECTIONS AND INITIATIVES

The database will provide information on park visitors studied nationwide and, possibly, data sets of each park's seasonal visitor information. For example, Map 2 shows the proportion of first-time visitors to various parks throughout the national park system. A large database will accrue, as 10-15 park studies could be added early.

The VSP is developing the capability to provide data on the economic contribution (i.e., jobs supported, sales and income generated) of park visitors during the study. Initial efforts began with an economic impact analysis of visitation to Lincoln Home NHS using IMPLAN, a computer modelling system developed by the U.S. Forest Service.

The VSP initiative is an interdisciplinary tool that can help the NPS constantly improve managerial efficiency and applicability. For example, visitors touring the White House strongly confirmed the need for a visitor center. Similarly, visitors to Lincoln Home NHS endorsed a new combination of first-come, first-served and advance reservations for tour tickets. And Denali NP was able to show support for the shuttle bus system because the service enabled a high proportion of users to view key wildlife species.

Through systematic baseline surveys of visitors, such as those conducted by the VSP, new management strategies may be developed. The potential for the consistent application of these data to a broad range of park management issues shows that visitors' views are important and beneficial.

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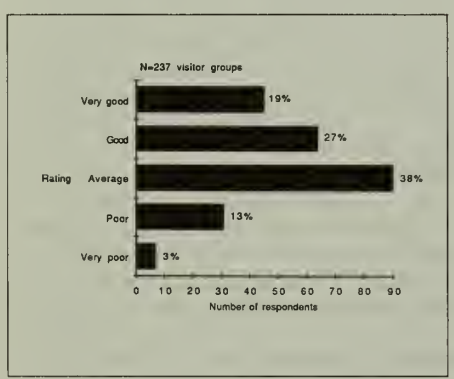
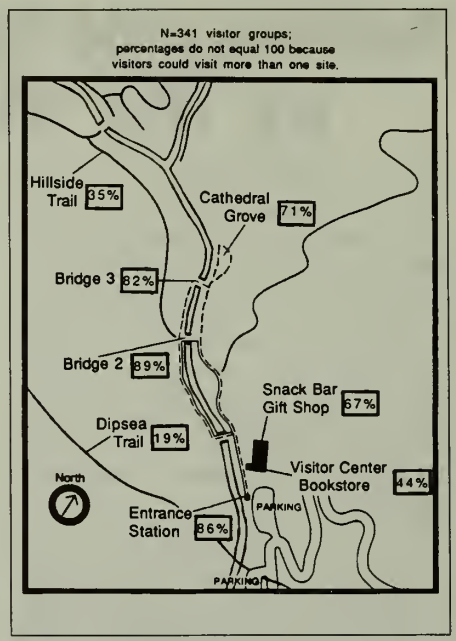


Figure 4. Visitor quality ratings of restaurant, Statue of Liberty NM, 1989.



Map 1. Proportion of visitor groups visiting each site, Muir Woods NM, 1989.

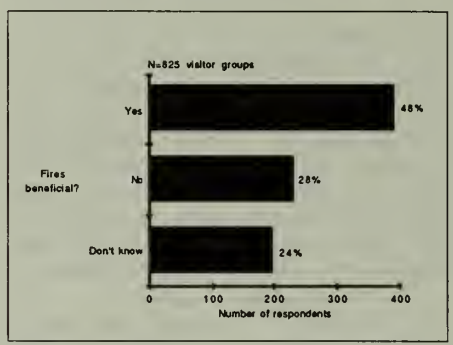


Figure 5. Proportion of visitors who viewed fire as beneficial to natural systems, Yellowstone NP, 1989.

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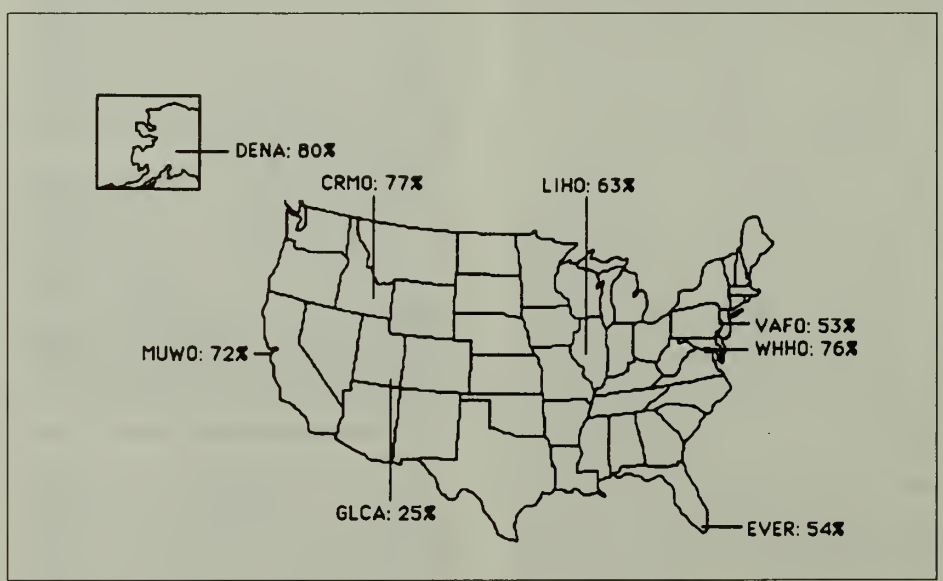
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Map 2. Proportion of first time visitors to various parks, VSP studies, 1986-89.

The Cumberland Island Cotton Mouse: A Unique Subspecies?

By James L. Boone, Joshua Laerm, and Michael H. Smith

The systematics of rare species often is problematic and may lead to the conservation and management of apparently rare organisms which are not truly rare (e.g. dusky seaside sparrow, Avise and Nelson, 1989; colonial pocket gopher, Laerm et al., 1982). Alternatively, inattention to the systematics of even common organisms may lead to the lack of concern for unique populations, subspecies, or even species that have not yet been identified. The cotton mouse *(Peromyscus gossypinus anastasae)*, occurring only on Cumberland Island National Seashore, GA, is an example of an apparently rare organism that has generated management concern. This population was considered the only extant representative of its subspecies, and therefore should have qualified for rare and endangered status. However, it never was listed because of questions concerning the validity of its taxonomic status.

This mouse originally was described in 1898 as *P. insulanus*, a distinct species, based on its small size and light colored pelage. Osgood (1909) reduced the species to a subspecies of *P. gossypinus* and classified it with the population of mice on Anastasia Island, FL as *P. g. anastasae*. The Florida population was considered for state and federal protection in the 1970s, but because of uncertain taxonomy, its status was listed as uncertain. The Florida population again was considered for federal protection in the mid-1980s, but it was found to be extinct, and the subspecies was declared UR-3 (no longer under consideration for listing due to the pervasive evidence of extinction.)

Although there were no data, federal officials stated they did not believe the Cumberland Island population was referable to *P. g. anastasae*. However, in the scientific literature, the extinction of the Anastasia population leaves Cumberland Island with the only extant population of *P. g. anastasae*. The subspecific status of this mouse was questioned by Osgood himself, but no systematic assessment had been conducted since his study. Recently, Boone (1990) reviewed the taxonomic affinities of the cotton mouse population on Cumberland Island to determine if this population was unique and if it deserved management and protection.

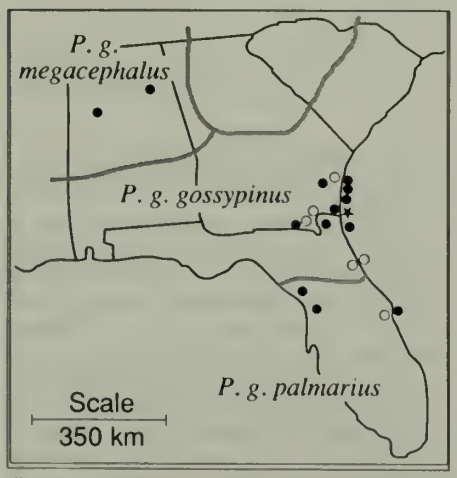


Figure 1. Southeastern United States showing locations (black symbols) from which specimens of 4 recognized subspecies of Peromyscus gossypinus *were collected. Gray lines indicate subspecies boundaries, Cumberland Island is indicated with a star, and unfilled symbols indicate sites from which genetic data were collected.*

Populations representing 4 subspecies of cotton mice from throughout Georgia, Florida, and Alabama were examined. Genetic analysis involved electrophoresis of the products of 44 loci in 379 mice from 14 populations, including 6 insular populations. (Figure 1). Morphological analysis involved examination of 27, mainly cranial, characters of 683 specimens from 20 populations, including the extinct Anastasia Island population.

Genetically, this species is highly variable both within and between populations. The percentage of polymorphic loci and heterozygosity per population is quite high, and their heterozygosity is twice the average reported for mammals. There is no evidence for inbreeding, drift, or founder effects reducing genetic variability on the islands despite large fluctuations in the numbers of mice on the islands. If migration between the mainland and the islands occurs, it appears to be limited, so the mechanism for maintaining genetic variability on the islands is unclear. Genetic distances among populations (Rogers, 1972) are relatively high for conspecific populations of mammals, and are comparable to the genetic differences among some *Peromyscus* species. As a group, the insular populations tended to have a greater degree of genetic differentiation than did the mainland populations.

Using genetic variance partitioning (Fst analysis) with the genetic data and discriminant analysis with the morphological data, essentially every population is significantly different from all others when tested in pairwise comparisons. Mice on Cumberland Island are genetically and morphologically significantly different from those on the mainland opposite Cumberland, and significantly different from these on the islands immediately north and south of Cumberland. If only these populations had been sampled, the Cumberland population probably would have retained its subspecific status. However, when all populations were examined simultaneously, the pairwise interpopulation differences became trivial and were not significant ($p>0.05$), as shown in Figure 2 for the morphological data. While each population was genetically and morphologically unique, no population was unusually distinct, and neither the Cumberland Island nor Anastasia Island populations of *P. g. anastasae* was sufficiently different from other populations to warrant recognition as a separate subspecies. Thus, there is no basis to support the subspecific status of *P. g. aanastasae*, and these mice should be designated *P. g. gossypinus*, the common mainland species.

Removing subspecific status from the mice on Cumberland Island, *P. g. anastasae*, and grouping them with *P. g. gossypinus*, does not imply that the Cumberland Island mice are genetically or morphologically identical to any other population or subspecies of *P. gossypinus*. Genetically, the Cumberland Island mice are unique and are well differentiated from other populations. For example, they have 5 alleles not found in any other population, and therefore represent a genetic resource that deserves conservation.

Other biota on the islands also will probably be found to be genetically differentiated. Rowland (1989) found

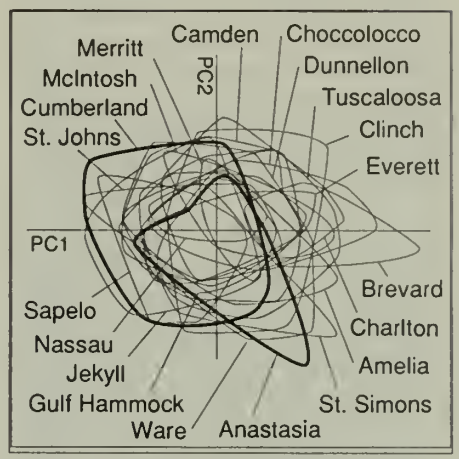


Figure 2. Distributions of 20 populations of Peromyscus gossypinus *on the first two principal component axes extracted from the covariance matrix constructed with data from 27 morphological characters.*

the white-tail deer *(Odocoileus virginianus)* on Cumberland Island to be genetically significantly different from deer on the mainland, and deer on Black Beard Island just north of Sapelo are genetically the most divergent of any white-tail deer population studied in various parts of the southeastern United States (Hillestad, 1984). These deer populations tend to have relatively high frequencies of rare alleles similar to the situation in the Cumberland mice. Thus, even if the islands do not provide habitat for any known unique subspecies, if our goal is to conserve biological diversity, then conservation of biota on these islands is particularly important because in many cases this biota contains the most genetically divergent populations in the species.

This study was supported by the NPS/CPSU at U/GA, the U/GA Museum of Natural History, and Savanna River Ecolgy Laboratory under contract between the US Dept. of Energy and U/GA's Institute of Ecology. Final reports concerning the taxonomy and conservation of this mouse will be submitted for publication elsewhere.

Boone is with the U/GA School of Forest Resources and Laerm is with the U/GA Museum of Natural History, Athens, GA; Smith is with the Savannah River Ecology Lab, Aitken, SC.

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Population consequences of indeterminate growth in tropical sea urchin *Diadema antillarum:*

A Sea Urchin's Response to Mass-Mortalities

By Don R. Levitan

The tropical black sea urchin *Diadema antillarum* is well known in the Caribbean for its long and poisonous spines. Before 1983, it was abundant and had a profound influence on coral reef communities. This urchin grazed up to 20 percent of the reefs primary productivity (Hawkins and Lewis 1982), bioeroded large areas of the reef (Stern and Scoffin 1977), competed with herbivorous fish (Hay and Taylor 1985, Carpenter 1986), and influenced the successful settlement and survivorship of corals (Sammarco 1982). *Diadema* is an extremely influential species in the Caribbean.

During 1983-84, a mass-mortality, due to an unknown pathogen, destroyed 99 percent of this species throughout the Caribbean (Lessios et al. 1984). With the help of the NPS in U.S. Virgin Islands, I have been investigating the population ecology of *Diadema* in an attempt to understand the dynamics which led up to and followed this unprecedented mortality event.

In the summer of 1983 (6 mo. prior to the mass-mortality), a census program was started on St. John, U.S. V.I. This monitoring effort indicated that *Diadema* exhibited an inverse relationship between body size and population density (Levitan 1988a). Laboratory and field experiments documented that this relationship was due to individual sea urchins adjusting body size by growing or shrinking based on food availability. Urchins growing or shrinking to a food- or density-dependent body size were not significantly different in measurements of test diameter, weight, gonad volume, or survivorship (Levitan, 1989a). Further experiments indicated that migration out of food-limited conditions on the reef was found to be disadvantageous, since predation pressure off the reef was significantly higher than on the reef (Levitan and Genovese, 1989).

These results may provide insight as to the rapid spread and magnitude of the mass-mortality. Increased population density, through planktonic settlement, results in reduced body size and not increased mortality (Levitan 1989a). Without density-dependent population regulation, population size increases unchecked. Previous to the mass-mortality this urchin was extremely abundant (i.e., 72/m^2 in Jamaica: Sammarco 1982). High population density may have facilitated the spread of the water-borne pathogen, by increasing the probability of urchin to urchin transmission (Lessios 1988, Levitan 1989a).

The monitoring program has continued on St. John, following the response of the surviving urchin population and its algal resource. By the summer of 1984 (6 mo. after the mass-mortality), urchin abundance had dropped from 15/m^2 to less than 0.1/m^2. The urchins resource, benthic algae, increased 3000 percent in biomass (Levitan 1988b). Since 1984, the surviving *Diadema* have increased in size dramatically. At present (June 1990), median urchin weight is over 300 g; an order of magnitude greater than the median weight of 20 g, previous to the mass-mortality (Levitan 1988b). Population density has not increased since 1984. Predictions suggested that this urchin would rapidly return to former abundances, since individuals were growing rapidly and producing large quantities of gametes. There are two probable reasons for the lack of juvenile recruitment.

The first reason involves the reproductive biology of *Diadema*. Sea urchins, like many marine invertebrates, release unfertilized eggs and sperm into the water. In order to guarantee a high rate of fertilization,



males and females must release gametes in close proximity to one another (Pennington 1985, Levitan 1989b). Following the mass-mortality, population density has been too low to insure fertilization success. Field experiments on St. John indicate that although urchins are now much larger and producing more gametes than before the mass-mortality, fertilization rates are so low that very few larvae are being produced (Levitan 1988c, 1989b).

The second reason for poor recruitment involves the scale of the mass-mortality. This event was widespread, affecting all Caribbean populations. If the event was local, other source populations could have restocked St. John; larval *Diadema* spend from 8 to 12 weeks in the plankton before settling (Carpenter personal communication). At present, the only known source population is in the Canary Islands, in the Eastern Atlantic (Lessios 1988). The only Caribbean island receiving substantial recruitment is Barbados, the eastern most Caribbean island (Hunte and Younglao, in press). It may be that larvae are traveling across the Atlantic and settling on Barbados (Carpenter personal communication). The high recruitment could also be due to island eddies keeping larvae produced at Barbados nearby, rather than dispersing them away (Hunte and Younglao, in press). If *Diadema* populations on Barbados can return to high enough densities, it may have a downstream cascading effect which could repopulate the rest of the Caribbean (Levitan 1989).

During the past year hurricane Hugo struck the Virgin Islands killing large numbers of *Diadema*. Adult population density declined almost an order of magnitude in many of the census sites. Fortuitously, large numbers of urchins settled on St. John since the storm. Populations at such low numbers should be monitored carefully since the probability of local extinction is relatively high.

In any event, *Diadema antillarum* will not return to former densities for several decades, if at all. Since this species has a major influence on many reef processes, this suggests that Caribbean reefs will remain changed as well.

Levitan is a post-doc researcher at the Banfield Marine Station, Univ. of Alberta; this work was part of his doctorate in Biol. Sci. at U/Del.

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Director's Awards

Francis Singer, Research Ecologist at Yellowstone NP, and David Haskell, Chief of the Resources and Science Division at Shenandoah NP, are the recipients of the second annual Science and Natural Resource Management awards, instituted in 1989 by NPS Director James M. Ridenour.

Singer is being honored for research contributions to natural resource management issues at Yellowstone, particularly his ungulate work. He has conducted, supervised, and directed significant research on the ungulate prey base for potential reintroduction of the gray wolf at Yellowstone, elk winter kills after the 1988 Yellowstone fire, and effects of native ungulate browsing on Yellowstone's northern range.

Haskell is recognized for his leadership in a 6-year effort to implement a long-term environmental monitoring program at Shanendoah. He has obtained continued park and regional management and fiscal support, worked effectively with university scientists to design the program, hired high quality staff, and integrated his staff and program into park operations for long-term program viability.

The awards were scheduled for formal presentation at the September Regional Directors' meeting.

regional highlights

Southeast Region

Protecting Biological Diversity in the National Parks: Workshop Recommendations, Transaction and Proceedings Series #9, is a handsomely illustrated 80-page account of the May 1988 workshop held at Great Smoky Mountains NP. Editors were Dominic Dottavio, Peter F. Brussard and John McCrone. Vern Nippensteal's pen and ink drawings on the cover and in the text depict important examples of the rich biological diversity native to the Great Smokies and the surrounding southern Appalachians. Copies are availabe from Donna O'Leary, NPS Publications Coordinator, c/o Air Quality Division, PO Box 25287, Denver, CO 80225.

• • •

Everglades NP has received additional funding for an exotic plant control program in the East Everglades Area (soon to be acquired as part of the park). The funding ($792,000) is a result of the mitigation requirements by the State Department of Environmental Regulation for the State Department of Corrections to build additional correction facilities.

Beginning in 1990, the South Florida Water Management District will also provide $60,000 each year for the next 3 years of the project as part of overall funding ($1,500,000) for exotic control in South Florida. These funds augment an already existing interagency fund supported by Dade County Department of Environmental Resource Management (mitigation funds), the State Department of Environmental Regulation (grant requests from the "Pollution Recovery Act") and Everglades NP. As a result of past work and planned work using new funding, we will have successfully controlled over 3 million exotic trees covering over 75,000 acres of quality wetlands.

• • •

The Southeast Region has established three new divisions in the Office of Science and Resource Management: (1) Coastal and Marine Ecosystem Research; (2) Terrestrial Ecosystem Research, and (3) Natural Resource Management and Policy. The ecosystem research approach is to develop information for the management of ecosystems and environmental concerns that are multi-park in scope. Research and research administration positions are being established that will be attached to academic institutions to develop specific elements of the ecosystem research programs and to assist in developing I&M, data management, and GIS programs.

• • •

Cooperating in educational efforts related to park problems is part of the mission of CPSUs, and for the past two years, at the U/TN CPSU, Dr. Stephen Nodvin has organized a seminar course on Environmental Impacts to Natural Ecosystems. This year Nodvin will assist in presenting an Introductory Course on Forest Soils and Watershed Management. He will be part of a team of scientists, cooperating to offer the course while the shoes of retiring Prof. Frank Woods are being filled. Major topics of forest soils and watershed management will be covered by Helga van Miegroet (Oak Ridge National Lab) and Jim Patrick (USFS-retired). Nodvin will handle ecosystem and park-related issues.

• • •

When Mrs. Marion E. Bailey of Largo, FL, died on Nov. 17, 1988, she bequeathed nearly $130,000 to the NPS "for the purpose of preserving and benefitting wildlife." Even as significant an amount as $130,000 would have disappeared in time had it been used for direct funding of individual wildlife management or research activities. A suggestion was made to create an endowment fund to support wildlife-related graduate research in NPS areas in the Southeast. Requests for proposals went to five universities in the southeast having graduate wildlife programs. The Clemson University proposal, which offered as much as a 3-1 ratio of matching funds, was selected. A cooperative agreement now is being established for administration of the Marion E. Bailey Scholarship Fund for Wildlife Research in the National Parks of the Southeast Region.

• • •

A cooperative agreement was signed recently with The Nature Conservancy to systematically search for and compile existing information on plants and animals of special concern to parks in south Florida and the Caribbean, with emphasis on coral reefs and marine ecosystems. Project costs will be shared equally by NPS and TNC. The information collected will be stored in the South Florida/Caribbean Natural Heritage Data Center housed at Everglades NP. The Data Center is part of the nationwide network of Natural Heritage Program databases.

In another cooperative project, the Southeast Regional Office worked with TNC to develop a proposal for using the Natural Heritage Program network to share biodiversity information across parks, regional offices, and WASO. Funding was provided for a pilot project linking the Mid-Atlantic and Southeast Regions with WASO.

• • •

A major evaluation of several proposed water delivery schedules for Everglades NP was produced by the staff at the NPS South Florida Research Center. The 99-pages report, plus appendices, recommends a "Basic Rain-Driven" water delivery schedule, along with major structural changes in the delivery system, as the best plan for reestablishing more natural hydrological species in the southern Everglades. In response to recent controversy regarding ecosystem vs. endangered species approaches to Everglades management, the SFRC report (edited by R.A. Johnson and J.C. Ogden) demonstrates why the ecosystem approach will also be most beneficial to the principal

Continued on page 10

meetings of interest

1990

Oct. 13-19, NATURAL AREAS/YOSEMITE CENTENNIAL SYMPOSIUM, at Yosemite NP and the San Francisco Bay area; jointly sponsored by the Park and the Natural Areas Assn., "Natural Areas and Yosemite: Prospects for the Future;" contact: Coordinator, Natural Areas/Yosemite Symposium, GGNRA, Fort Mason Bldg., #201, San Francisco, CA 94123; (415) 556-1009; FAX (415) 556-1399.

Nov. 12-15, RESOURCE TECHNOLOGY 90, Second International Symposium on Advanced Technology in Natural Resource Management; at Georgetown University Conference Center, Washington, DC. Contact Resource Technology 90, 2625 Redwing Road, Drake Executive Plaza, Suite 120, Fort Collins, CO 80526-2878; (303) 226-1688; FAX (303) 226-1688.

Nov. 12-17, SIXTH CONFERENCE ON RESEARCH IN THE NATIONAL PARKS AND EQUIVALENT RESERVES, at the Westin Paso del Norte Hotel, El Paso, TX; Contact: Conference Committee at (415) 556-1866.

Nov. 27-29, NEW PERSPECTIVES FOR WATERSHED MANAGEMENT; Balancing Long-Term Sustainability With Cumulative Environmental Change, sponsored by U/WA Center for Streamside Studies and OR/St/U Col. of Forestry, at U/WA, Seattle. Contact: Continuing Education, Coll. of Forest Resources, AR-10, U/WA, Seattle, WA 98195 (206) 543-0867.

1991

May 14-19, INTERNATIONAL CONFERENCE ON SCIENCE AND THE MANAGEMENT OF PROTECTED AREAS, at Acadia University, Wolfville, N.S. Canada. To serve as a forum for examining current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research, and as a lead-up to the IUCN World Parks Conference, 1992. Contact Neil Munro, Director, Policy Planning & Research, Canadian Parks Service, Atlantic Region, Environment Canada, Historic Properties, Halifax, Nova Scotia, Canada, B3J1S9.

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

October (no date given in initial announcement), SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme, "The Wildland/Urban Interface," at Lake Tahoe, interfacing resource managers and scientists in small group discussions of research findings. Sponsored by USFS, BLM, Society of American Foresters and others. For information write Debbie Chavez, SARR Symposium Coordinator, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

Nov. 4-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL, in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Contact: Gabriel Cherem, EMU Geography & Biology, Ypsilanti, MI 48197; (313) 487-0218, or Ray Tabata, UH Sea Grant, (808) 948-3191.

Southeast Region *(Continued)*

endangered species (Wood Stork, Snail Kite) potentially affected by the restoration program.

* * *

David Moon, hydrologist, is finishing set-up of an enhanced hydrologic network to monitor water levels and rainfall in the Shark River Slough, Everglades NP. Data collection over the next two years will allow for assessment of long-term hydrologic monitoring needs and provide data necessary for hydrologic restoration options. A project methodology report will be published this winter.

Midwest Region

The St. Croix National Scenic Riverway brought out the divers and waders of the USFWS, the Wisconsin Dept. of Natural Resources, and its own staff to check on the status of the federally proposed-for-listing winged Mapleleaf mussel *(Quadrula fragosa)*. Known only from a 5-mile stretch of the St. Croix River below a hydroelectric facility, the population beds may have been severely impacted by de-watering and freezing temperatures during the winter of 1989-90. Preliminary results were not encouraging; only a few individuals were found. Further monitoring continued during the late summer low water period.

* * *

Pipestone National Monument was chosen by the Minn. Dept. of Natural Resources as one of the 5 host sites for the Minnesota Prairie Heritage Day, held on Aug. 11, 1990. This was the fourth annual celebration of Prairie Day in Minnesota. The day is designed to focus attention on the less than 1 percent remaining of original prairie, which once consisted of nearly 18 million acres. Pipestone NM was designated as a Natural Heritage Area in Minnesota in 1983.

* * *

A detailed vegetation map of Pipestone NM, produced through a GIS at the University of Nebraska-Lincoln, will help park staff better manage the cultural and natural resources of the monument. Using ARC/INFO software, a GIS is being developed for Pipestone. To make the GIS possible, 12 to 14 digitized map layers must be produced, depicting factors that affect vegetation type and distribution (e.g. slope, drainage, elevation, soil type, historic land-use changes and old fence lines). Similar projects are slated for Wilson's Creek National Battlefield in Missouri and Scotts Bluff National Monument in Nebraska.

* * *

For the third year, biologists from three land management agencies, a local university, a national conservation group, and key members of the public met at Pictured Rocks National Lakeshore to discuss coordinated efforts toward protection and recovery of the federally listed (endangered) piping plover *(Charadrius melodus)*. Federal and state agencies have essentially no land holdings within critical plover nesting areas. Protection efforts thus rely almost entirely upon local governments and private citizens. The information that was generated at the third annual meeting has led some resort owners who possess critical beach habitat to take a strong interest in the plover. The Michigan Dept. of Natural Resources has provided funds for annual monitoring and local governments have prohibited over the road vehicles on critical beach habitat. NPS cannot afford to operate on the assumption that its boundaries have biological meaning.

Mid-Atlantic

Chief Scientist John Karish reports availability of a report by Julie Downs and Marc Abrams of PA/St/U titled ***Friendship Hill National Historic Site Vegetation Study*** (Tech Rpt. NPS-/MAR/NRTR-90/045). Notable findings include detailed sampling data from an old-growth oak forest where over 90 percent of the trees are greater than 120 years old, some over 300.

* * *

A Social Science Research plan for Delaware Water Gap NRA has been developed by Gary Machlis, of the Visitor Services Project. Such a plan represents an organized, written strategy for acquiring social science information useful to park management. The plan reviews existing social science research relevant to the park, identifies research needs, and outlines a 4-year action plan for implementing social science at the park. The plan is the first of its kind and is intended to represent a model for similar plans in other parks. Interested persons may contact Gary Machlis, U/ID, Dept. of Forest Resources, Moscow, ID 83843; (208) 885-7129.

* * *

From David Haskell, Shenandoah NP's Chief of Natural Resources and Science, comes news of the park's 12th Biennial Research and Resource Management Symposium May 10-11. The 12 papers given ranged from "The Response of Black Bears to Gypsy Moth Defoliation" to "Watershed Acidification and Spatial Variability of Mountain Headwater Streams of Shenandoah NP."

Second day discussion groups focused on the effects of acid deposition and ozone on park resources, and the Shenandoah Related Lands Initiative, identifying information and research needs.

The first meeting of the park's new Science Review Board (see box) was held. This 7-member board was established to provide oversight and assistance to the park's research program and to review annually the application of science to the management decision-making and problem-solving process.

* * *

During the May symposium at Shenandoah NP, James Galloway was awarded the park's Excellence in Service Award for his outstanding contribution to the protection and management of the park's natural resources. For the past 10 years, Dr. Galloway has been the principal investigator for the Shenandoah Watershed study, a long-term research and monitoring program conducted under cooperative agreement with the park. The program is focused on gaining better understanding of watershed response to acid deposition and is the longest running watershed study within an NPS unit. Dr. Galloway also is a member of the park's newly-formed Science Advisory Board.

* * *

Five members of Shenandoah NP's Division of Natural Resources and Science were presented with special achievement awards for outstanding accomplishments in 1989: Supervisory Natural Resource Specialist Rick Potts, Administrative Assistant Debra Sanders, Geographic Information System Specialist Alison Teetor, Air Quality Specialist Jim Watkins, and Air Quality Technician Rolf Gubler.

Shenandoah National Park Science Advisory Board

The need to expand and strengthen the NPS science program has been recognized for years. This need was highlighted in the 1988 National Park System review conducted by the National Parks and Conservation Association (NPCA). Volume 11 titled, ***Research in the Parks,*** contained 14 major recommendations, one of which was that Congress should establish a Science Advisory Board (SAB) to provide an expert assessment of NPS natural, cultural, and social science needs and programs.

This need also has been recognized at the field level. Glacier NP has had a review board in operation for several years with very good results. Shenandoah NP established its 7-member Science Advisory Board (SAB) in May 1990. The first board meeting was held in conjunction with the Park's 12th Biennial Research and Resource Management Symposium held in May. The membership is made up of subject matter experts in a wide range of areas including the social sciences. They elected their own chairman, Dr. Robert Adams, head of the Department of Forestry and Wildlife Sciences, Virginia Polytechnic Institute and State University. Initially four of the members will serve two year terms and the remaining three members will serve for three years, thus maintaining program continuity during the first few years. All second terms will be for three years.

The goal of the SAB is to assist the Park Superintendent in the effective protection and management of the natural and cultural resources of the park. As stated in the SAB by-laws, the primary focus will be on providing an annual assessment of the effectiveness of the park's research program and how scientific information is used to make important decisions. Although the Board will not be asked to conduct peer reviews, an examination of the peer review process would be appropriate. The Board may also be asked for input or evaluations on specific management problems or decisions. In response to the SAB's annual report on their findings, the Superintendent agrees to reply in writing to specific recommendations within 60 days. This process will assure timely feedback to the SAB on how their efforts are affecting and contributing to the decision making process.

David A. Haskell
Shenandoah NP

Rocky Mountain

The Artificial Intelligence group at Colorado State University is investigating the possibility of forecasting backcountry and wilderness recreation use using innovative computer techniques. The immediate project is a comparison of neural networks/back-propagation for tend identification with exponential smoothing and box-jenkins. The project leader is seeking test data sets and wants to contact others interested in AI and forecasting. Additional areas include embedding neural networks in GIS systems. Contact Douglas Pattie, Dept. of Recreation Resources, Colorado State U, Fort Collins, CO 80523; (303) 491-6477 or 6591; FAX (303) 491-2255.

* * *

Further submissions from Rocky Mountain Region will appear in the Winter issue.

Water Resources Division

Terence P. Boyle, Research Ecologist with the Water Resources Division, spent nearly a month in Argentina and Uruguay last winter, attending the Primer Congreso Latino Americano de Ecologia meeting in Montevideo, where he led a workshop on the use of resource inventories in ecosystem risk assessment and environmental protection; conferring with various scientists, and visiting institutions in Argentina the week before and after the Congress. Boyle described the conference as similar in scope to an Ecological Society of America meeting, but expressed disappointment that regional problems were not presented within a framework that recognized the international nature of such problems.

Boyle met with Marta Balderiote, head of the Argentine MAB committee, and her staff for discussion of activities at Argentina's four MAB sites. One of the four areas – Parque Dostero del Sur – consists of a narrow belt (30,000 ha) of Spartina marsh and dune communities of Celtis abutting the coast. This area, which contains several small towns, has been discussed as a potential sister area with Cumberland Island NS for comparative studies with U.S. NPS and MAB.

North Atlantic

The recently established NPS Coastal Research Center at the University of Rhode Island, a CPSU, now is fully operational. Charles Roman, Unit Leader and wetlands ecologist, along with James Allen (coastal geomorphologist), P.A. Buckley (seabird and colonial waterbird ecologist), Howard Ginsberg (entomologist/invertebrate ecologist), and John Tanacredi (environmental toxicologist/ecologist), form a diversified NPS staff capable of addressing issues relevant to coastal parks. Tanacredi, a Gateway NRA based scientist, will commit 30 percent time to the coastal unit. URI researchers, mostly serving in collaboration with the NPS scientists as principal investigators, are becoming actively integrated into numerous research projects at North and Mid-Atlantic parks. Future collaboration with units of the Southeast Region is expected, especially with respect to accelerated sea level rise and related effects on coastal resources and processes.

. . .

A two-day conference on Science and Resource Management in the North Atlantic Region is being planned for late Winter-early Spring 1991, in Newport RI. A similar conference in 1987 (Amherst, MA) was a great success and we are looking forward to providing once again a forum for NPS and university researchers, resource management specialists, and superintendents to interact. Please contact Regional Chief Scientist Mary Foley or URI/CPSU Leader Charles Roman with recommendations for session topics.

. . .

Dr. Howard Ginsberg recently joined the Office of Scientific Studies. He is duty-stationed at the URI/CPSU. For the past five years, Ginsberg has been an assistant research professor at Rutgers University with a research focus on tick ecology and Lyme Disease. Working in conjunction with the Rutgers Cooperative Research Unit, his research focused on Fire Island National Seashore and other parks of the North and Mid-Atlantic Region. In his new position, Howie will continue to pursue the ecology of insect-borne diseases as well as focusing on biodiversity issues.

Northern Spotted Owl Is Threatened

In June, 1990, the USFWS designated the northern spotted owl a threatened species throughout its range under provisions of the Endangered Species Act. The scientific basis for this determination is presented in a concise report prepared by a 5-person "listing team" of USFWS biologists (Anderson et al, 1990).

Briefly, the USFWS team examined the habitat relationships, population dynamics, rates of habitat fragmentation, and the existing regulatory mechanisms to protect the bird before recommending threatened status. In one particularly interesting comparison of owl occurrence and reproductive performance they conclude that the "... spotted owl habitat in protected areas [e.g. wilderness areas and parks] is too fragmented, isolated, and poor in quality to support a viable population of northern spotted owls." These independent analyses support and expand interpretations on the status of the owl made earlier by the Interagency Scientific Committee (Thomas et al, 1990). They also underscore NPS concerns that persistence of the birds in national parks, particularly the mountain parks of Washington and Oregon, may depend upon retaining populations outside.

Doug Houston, *Research Biologist*
Pacific Northwest Region

References

Anderson, D.R. et al. 1990. 1990 Status review, Northern Spotted Owl (Strix occidentalis caurina). U.S. Fish and Wildlife Service Report. 95 pp.

Thomas, J.W. et al. 1990. A conservation strategy for the northern spotted owl. Report of the Interagency Scientific Committee. May, 1990. 427 pp.

Pacific Northwest

Dr. R. Gerald Wright, Research Biologist at the NPS CPSU at U/ID, has been selected from this region to be on the NPS Liaison Committee, established to facilitate communications with the National Academy of Sciences Committee reviewing and evaluating scientific research in the NPS.

. . .

After an early spring "stir" over sighting of an adult wolf in the drawdown of Ross Lake in the North Cascades National Park complex, automatic cameras were set up at two locations within the Hozomeen area in the hope of recording a wolf visit to the bait (which was roadkill ugulate parts). By mid-August the cameras were removed. The camera crew had developed great photographs of black bears, ravens, jays, mountain lions, and coyotes – but no wolves, and no grizzly bears.

Meanwhile, several of the park staff (Ross Lake and backcountry people) were trained in how to howl like a wolf and how to recognize a wolf response. Howling transects were being conducted in the area throughout the summer.

. . .

In response to a lawsuit filed against the NPS by the Sierra Club Legal Defense Fund, representing the North Cascades Conservation Council (also known as N3C), the NPS is preparing an Environmental Impact Statement (EIS) dealing with the concerns expressed by N3C. The EIS is examining firewood management, land protection, transportation, wilderness, sand, rock and gravel extraction sites and uses, and management alternatives for the Stehekin River.

. . .

Will the elk in Olympic NP persist over time? That's the question constituting the title of an article by Douglas B. Houston, Ed G. Schreiner, and Bruce B. Moorhead of Olympic NP and K.A. Krueger of Bellevue, WA, in the ***Natural Areas Journal*** Vol. 10(1), 1990, pp 6-11. Recent studies of elk *(Cervus elaphus)* distribution, density, life habits, and vegetation relationships suggest that migratory subpopulations along the east side may be vulnerable because of their low numbers and increased urbanization of winter ranges outside the park. In contrast, subpopulations along west side drainages that winter in rain forests are thought to be comparatively secure.

. . .

A draft final report on the Crater Lake hydrothermal research begun in 1986 at the behest of Congress (see ***Park Science*** Spring 1989) is due September 1990 from Drs. Jack Dymond and Robert Collier – two oceanographers from Oregon State University, who developed a research plan to examine the lake floor for hydrothermal activity. The report, describing three years of dramatic and intensive research, will go through scientific peer review, after which the Secretary of the Interior will use to to prepare his report to Congress on the presence or absence of significant thermal features in Crater Lake NP.

Alaska Region

Recent personnel changes in the Region's Natural Resources staff gives us the following field area lineup: Bering Land Bridge, Rich Harris; Glacier Bay, Mark Schroeder; Katmai, Janis Meldrum and Ron Squibb; Kenai Fjords, Bud Rice; Gates of the Arctic, Judy Alderson; Lake Clark, Joe Fowler and Trainee Paul McLaughlin; Northwest Alaska Areas, Lee Anne Ayres and Jim Peterson; Wrangell-St. Elias, Russ Galipeau and Bill Rowdy; Yukon-Charley Rivers, Steve Ulvi and Penny Knuckles; Regional Office, Trainee Sue Mills.

. . .

Two radio-collared wolves (plus possibly more that were not collared) were killed in a snow avalanche in Denali. The collars permitted detection of this incident of nature in the raw, and recovery of the carcasses. The wolves were collared as part of an ongoing study under P.I. Dave Mech, FWS.

. . .

Episodic eruptions of National Natural Landmark Mt. Redoubt have created a nuisance in Southcentral Alaska since early winter, with portions of the landmark in the form of ash disrupting airline service and generally dirtying the landscape. This spring when the ice melted out of 45-mile-long Lake Clark, in Lake Clark NP and Preserve, the water – instead of its usual springtime deep turquoise color – was clouded with ash, making it look more like it does at the *end* of a summer, as a result of glacial silt. The redoubtable Dr. Bob Stottlemyer, who has studied the lake, was summoned for a prognosis.

Continued on page 12

Alaska Region *(Continued)*

Papers presented at the 70th annual meeting of the American Society of Mammalogists, Frostburg State Univ., June 9-13:

Dale, B.W., L.G. Adams, and R.T. Bowyer (UAF), Influence of late winter caribou availability on wolf predation (NRPP study in Gates of the Arctic); and Rachlow, J.L. (UAF), and R.T. Bowyer (UAF), Use and selection of lambing habitat by Dall's sheep (partial ARO funding, Denali).

* * *

This summer Alaska experienced one of the most active wildfire seasons since records have been kept. An article on the 1990 fire season in Alaska and a discussion of the effectiveness and efficiency of the interagency fire management plans is promised for the winter issue.

National Capital

Seth Riley, wildlife biologist at the Center for Urban Ecology (CUE), gave a paper on "Population Estimation for Raccoons *(Procyon lotor)* in an Urban National Park: 1982-1989" at the 70th annual meeting of the American Society of Mammalogists in Frostburg, MD. John Hadidian of CUE and David Manski of Cape Cod NS were co-authors.

* * *

John Short, soil scientist at CUE, is the PI for two research projects studying the urban soils of the Washington Monument grounds. The first project is designed to physically and chemically characterize these soils and to evaluate taxonomic criteria proposed for use with them. Preliminary results indicate that, as expected, the soils are highly compacted, have a variable organic matter content, a relatively high pH, and contain many contrasting layers of soil materials in a single profile.

Short has initiated a project to characterize the soil atmosphere of the Monument grounds soils. The compacted nature of the soil adversely alters the soil atmosphere and therefore quantitative data about these changes are needed. The methodology for obtaining samples has been selected and field sampling will begin soon.

* * *

The report "Preliminary Assessment of the Susceptibilities of Non-Target Lepidopteran Species to Bacillus thuringiensis (B.t.) and Dimilin Used for Gypsy Moth Suppression" has been completed. Copies of the report, by Adrienne Venables of the U/MD Dept. of Entomology, can be requested from Dr. James L. Sherald, CUE, National Capital Region, NPS, 1100 Ohio Dr., S.W., Washington DC 20242.

* * *

Limited investigations concerning ecology of hydrilla in the freshwater Potomac estuary have been reinstituted due to a dramatic population collapse in the study area in 1989. The collapse, which was unexpectedly strong and almost total in several reaches, has spurred investigation along several lines. Were such factors as turbidity and cloud cover alone enough to cause complete loss of plants? To what extent will hydrilla or other local submersed aquatic vegetation repopulate the supposedly vacant niche under the environmental conditions extant in 1990? Will heretofore weak pathogens and insects play a more dominant role in controlling hydrilla where the hydrilla population may be stressed?

Western Region

The Region is in the process of establishing a CPSU technical report series, to consist of prepublication material from research conducted in National Parks located within the Colorado Plateau. Anyone interested in being on the mailing list for these reports should send name, address, and affiliation (where the reports should be sent) to Charles van Riper III, Unit Leader; NPS/CPSU, Center for Colorado Plateau Studies, Box 5613, Northern Arizona University, Flagstaff, AZ 86011.

* * *

An 80-page Technical Report (#40), by John A. Sacklin (in partial fulfillment of his master's degree in business administration at Humboldt State University in Arcata, CA), evaluates the operations evaluation process within the NPS and finds the process barely worth the effort as it now functions. One of the strongest recommendations was for more and better follow-up, providing incentive and merit pay systems to reward excellence based on the Operations Evaluation process, and revisiting troublesome areas at a later date to see what progress has been made. Also recommended was that Operations Evaluations results be analyzed to help justify Servicewide funding increases.

Everglades Classic Rewritten and Reissued

William B. Robertson, Jr., Senior Park Biologist at Everglades NP, has lovingly reworked the classic story of the Everglades and it has been beautifully published by the Florida National Parks and Monuments Association, Inc. Writes "Dr. Bill" in his Preface:



"As well as I can remember, I wrote the original draft of ***Everglades – The Park Story*** in two or three hectic weeks during the summer of 1958. Dan Beard said he wanted a park book and one didn't like to keep him waiting. After the customary editorial agonies, the book appeared a year or so later, suitably clothed in Dade Thornton's fine photographs. At that time it cost a mere buck and it stayed in print for nearly 20 years, while south Florida changed around it.

back from 1988, those days seem unimaginably remote. The park was still in its age of innocence: small staff, not much money, 20-hp outboards, few visitors. Specialization was a luxury we couldn't afford and serendipity lived."

The Preface goes on to describe the "archaic, unprogrammed zest" of the place then – days when "the glades flooded or they didn't flood, an act of God and that was that." And it winds up this way:

"Let us hope that the park continues relatively unscathed through the next several decades of testing confrontations and final adjustments. Then, when someone else sits down to write a better ***Park Story*** after a while, he can speak of wood storks and panthers and everything else that makes southern Florida wildlands such a glory to behold."

One doubts that a "a better story" will ever be written about the Everglades. Robertson's insights have provided the framework for 30 years of park research and resource management, and he is one of the few scientists whose writing skills match his scientific expertise.

This version of the book also is "suitably clothed" – with photographs by Glenn Van Nimwegen, whose work has appeared in ***Smithsonian, Audubon, National Wildlife,*** and other publications.

For information on the book, contact Florida National Parks and Monuments Assn., Inc., PO Box 279, Homestead, FL 33030.

letters

To the Editor:

If ***Park Science*** had a society column, this is the type of note it would carry:

"In 1989 a female peregrine hacked at Isle Royale in 1988 found a mate from Chicago and nested successfully on a building in downtown Milwaukee, Wisconsin."

. . . and they lived happily ever after!

The quoted material is from ***Ecological Studies of Wolves on Isle Royale, Annual Report, 1989-90,*** Rolf O. Peterson, School of Forestry and Wood Products, Michigan Technological University, Houghton, MI.

Also, you may want to do an article soon on the razorback sucker, an ugly fish that is just being proposed as endangered and which we have in Glen Canyon and Lake Mead. It's the fourth fish to be listed from the Colorado River system and symbolic of the entire issue of development and water use all over the west. Am. Fisheries Soc. identified southwestern fish as the most endangered in the U.S. last year and said the trend is down. Most people don't think of fish when they think of endangered species.

Margaret Osborne
Endangered Species Program Analyst
NPS Washington Office

Editor's Note: Margaret has kept us on the ball about desert tortoises, Florida panthers, red wolves, and other rare and endangered sharers of the planet. We acknowledge her participation with enthusiastic thanks.

GLOBAL CHANGE

October 1990

This special section discusses potential Impact and Implications for the NPS

The greenhouse effect is real – a natural function of various constituent gases in the atmosphere that limit the radiation of heat energy from the Earth to outer space. Without the greenhouse effect, the Earth's surface would be about 60 degrees C cooler.

The overarching indicator of global change is a persistent trend toward worldwide climate change that goes beyond so-called normal variation and that seems likely to lead to intensified and unpredictable events in nature.

The concern of the world's governments and the scientific community is manifest in unprecedented basic research initiatives to detect, understand, and predict global change. These initiatives involve an expanding network for cooperation in setting research priorities and objectives and gathering, sharing, storing, retrieving, and utilizing relevant data. U.S. participation in these initiatives is backed by a substantial budget for global change research (see Table 1).

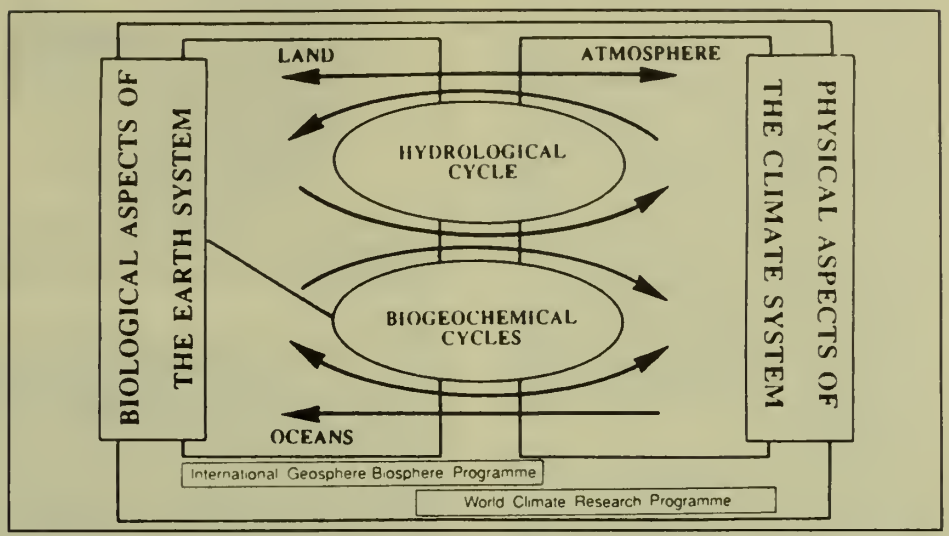
The greenhouse effect has become an issue of global concern because

- the cumulative effects of human (anthropogenic) influences in increasing the concentration of greenhouse gases appears to be either causing climate change or accelerating natural cycles and trends, and
- these changes seem to be occurring at a rate 10 to 60 times faster than any known previous climate change.

The evidence so far shows the Earth to have warmed about 0.5 degree C (about 1 degree F) in the past 100 years. Although a number of periods of both cooling and warming took place during that time, the six warmest years on record all have occurred within the past decade. The Earth now is warmer than at any time in *recorded* history.

If global warming is in fact occurring, the actual mean temperature increase involved will not be the primary focus of concern for natural resource managers. Rather, it will be the magnitude, frequency, geographic extent, and duration of the climatic "events" – the episodic events of wildfire, hurricanes, drought, etc. – that could accompany even a modest overall warming. These are the kinds of events that are known to cause significant changes in ecosystems. These changes, if

Continued on page 2



Linkages among biological, chemical and physical processes critical to our understanding of global change on a decade-to-century time scale. Arrows refer to the seven first research priority questions as described in The IGBP Global Change Report, #12, 1990.

Table 1: FY 1990-1991 U.S. Global Change Research Program Focused Budget (Dollars in Millions)

Focused Program	Total Budget		Climate & Hydrologic Systems		Biogeochemical Dynamics		Ecological and	Systems Dynamics	Earth System History		Human Interactions		Solid Earth Processes		Solar Influences	
	FY90	FY91	FY90	FY91	FY90	FY91	FY90	FY91	FY90	FY91	FY90	FY91	FY90	FY91	FY90	FY91
Agency Totals	659.3	1034.1	291.7	461.5	198.7	265.8	90.2	178.6	7.7	19.1	4.8	15.0	57.4	80.9	8.8	13.2
DOC/NOAA	18.0	87.0	14.2	67.6	3.3	13.5	0.0	4.9	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0
DOE	50.0	66.0	32.0	44.0	7.0	9.0	9.0	10.0	0.0	0.0	2.0	3.0	0.0	0.0	0.0	0.0
DOI	13.3	43.7	4.9	12.2	0.8	2.0	0.9	10.3	2.4	8.0	0.9	5.3	3.4	5.9	0.0	0.0
EPA	13.2	26.0	1.0	3.3	2.5	3.1	9.7	19.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NASA	488.6	661.0	221.4	302.5	162.2	198.3	51.0	90.0	0.0	0.0	0.0	0.0	47.7	63.0	6.3	7.2
NSF	55.0	103.0	16.8	29.8	20.2	32.2	3.5	8.5	4.5	9.0	1.2	5.5	6.3	12.0	2.5	6.0
USDA	21.2	47.4	1.4	2.1	2.7	7.7	16.1	35.3	0.3	1.1	0.7	1.2	0.0	0.0	0.0	0.0
Scientific Objective																
Observations	137.2	255.0	89.1	148.9	17.2	38.9	14.1	39.6	0.0	0.2	0.0	2.2	13.1	20.8	3.7	4.4
Data Management	65.2	129.4	32.9	64.0	21.2	34.7	5.5	17.7	0.5	2.2	0.4	1.0	3.8	8.8	0.9	1.0
Understanding	409.7	560.0	143.1	200.3	148.1	176.2	65.5	103.2	6.1	13.1	2.9	10.6	40.5	50.1	3.5	6.5
Prediction	47.2	89.7	26.6	48.3	12.2	16.0	5.1	18.1	1.1	3.6	1.5	1.2	0.0	1.2	0.7	1.3

***The Assistant Secretary** of the Interior for Fish, Wildlife, and Parks is the Departmental overseer of the NPS Global Change Program, which is headed by NPS Assistant Director for Natural Resources Eugene Hester. The Global Change Program organizational chart is available from the Regional Chief Scientists and from the new Washington Office Global Change Program Coordinator, Pete Comanor. (See bio, page 8.) (Table: From USGC Research Program Report for FY 1991, pp. 18-19.)*

and when they occur, will define the new limits within which resource managers will have to operate.

Circumstantial Evidence

The evidence on the climatological effects of anthropogenic increases in carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), and several minor greenhouse gases is circumstantial. But most global circulation models (GCMs) indicate that, with an equivalent doubling of CO2 levels by mid-21st Century, the average global temperature can be expected to increase by 3 to 5 degrees C (5 to 9 degrees F) (*Intergovernmental Panel on Climate Change,* May 2, 1990). The probability of an increase of this magnitude is subject to considerable debate, although even conservative authorities concede it at least a 50-50 chance – a probability level that, from a policy perspective, warrants significant concern.

In addition to the direct effects of climate change, an accelerated rise in sea level is expected as a result of warming-induced expansion of the oceans and potential melting of polar ice. According to the IPCC Report (referenced above):

"By 2030, even if greenhouse forcing increased no further, there would still be a commitment to a continuing sea level rise for many decades and even centuries, due to delays in climate, ocean, and ice mass responses. Sea level would go on rising from 2030 to 2100 by as much again as from 1990 to 2030, due to the effects of pre-2030 greenhouse gas increases alone." (See Figures, p. 7)

Changes much larger than those suggested by the GCMs have occurred many times in the Earth's geologic history and no doubt are likely to occur naturally sometime in the planetary future. However, never in human recorded history have such global climatic and related changes occurred at the rate projected and with the degree of human involvement that is now being investigated.

Uncertainties Abound

Many uncertainties cloud our predictions, particularly with regard to the timing, magnitude, and regional patterns of climate change. These uncertainties stem particularly from our incomplete understanding of:

- the sources and sinks of greenhouse gases, which affect predictions of future concentrations;
- the role of clouds, which strongly influence the magnitude of climate changes;
- the role of the oceans, which influence the timing and patterns of climate change;
- the role of polar ice sheets, which affect predictions of sea-level rise.

These dynamic earth system processes are partially understood. Proposed research will reduce the uncertainties, but the complexity of the overall system means that surprises cannot be ruled out, particularly with regard to natural systems.

Potential Management Problems

The potential ecological effects of a 3 to 5 degree C annual global warming projected to occur by mid-21st Century were discussed in the Conference on Consequences of the Greenhouse Effect for Biological Diversity, organized by the World wildlife Fund and cosponsored by the NPS and other agencies in October, 1988. The Conference provided a valuable summary of the kinds of effects likely to be of special interest to natural resource managers.

Some notable examples include changes in timing and rates of snowmelt, and associated effects such as acid pulse; and changes in the frequency of hurricanes, with reduced productivity of mangroves and other hurricane-influenced ecosystems. For some plant species, the direct effects of rising levels of CO2 in increasing the rate of photosynthesis (the so-called "CO2 fertilization" effect) and reducing evapotranspiration could be significant, with potential ramifications at the ecosystem, biome, and biosphere levels. Robin Graham, Monica Turner, and Virginia Dale have provided an excellent overview of the state of knowledge of the effects of CO2 and climate change on forests in the September 1990 issue of ***BioScience***.

There may be major shifts in distribution of common forest trees. Preliminary research indicates that the range of such important deciduous forest species as sugar maple, beech, yellow birch, and eastern hemlock might have to shift 500 km northward under global warming, with accompanying extinction throughout much of their existing ranges. Failure of reproduction in areas outside a species' climatological limits is likely to be an early sign of change.

Targets of Heat Stress

Animals that require multiple habitats for completing their life cycles, such as amphibians and migratory birds, could experience significant stress. Heat stress could affect the survival of embryos of ground-nesting birds, animals such as pocket mice that burrow underground to reduce heat loads, and cold-blooded species, such as many desert lizards, with distributions determined by temperature. It also could encourage increased aggression, competition, and other behavioral impacts on many animals. Natural shifts in ranges may be especially difficult for animals with low fecundity or low natural rates of dispersal. Animals known to be subject to temperature-induced switching of sex ratios, such as some turtles and geckos, could be at a particular disadvantage.

Species relationships, such as plant-herbivore interactions, and the distribution and abundance of parasites could change. The possibility of rapid proliferation of species, including disease organisms, able to invade habitats affected by climatic stress and related disturbances, such as wildfire, is a major concern.

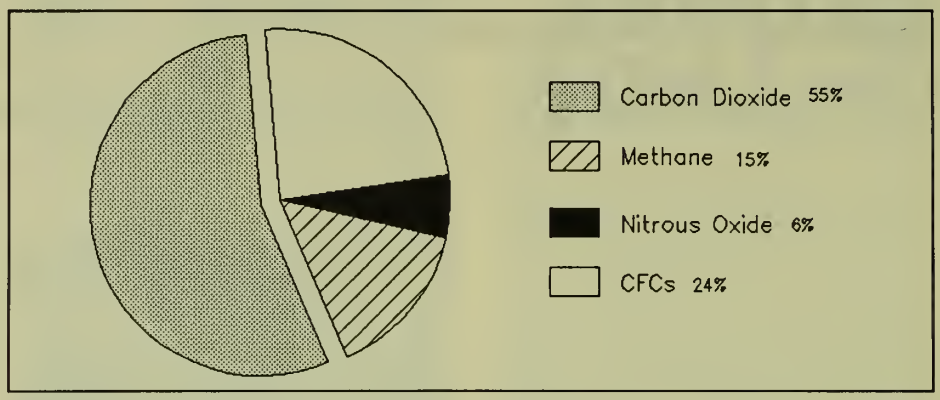
A Letter To The Parks

The list of ecological resources and regions likely to be especially vulnerable to the effects of climate change reads like a letter to the National Park System: Arctic tundra, and boreal forests; alpine, subalpine and relict communities; western forests; coastal lagoons, marshes, and coastal barriers; coral reefs; and many populations of endangered, threatened, rare, and endemic species. GCMs are in general agreement that the magnitude of global warming is likely to be greater at high latitudes and in mid-continental areas. In North America, these are areas where the National Park System is particularly well represented.

A large inventory of the nation's cultural resources also is potentially at risk from the effects of global change. Sea level rise could threaten lighthouses, coastal fortifications, archaeological sites, and other cultural resources in coastal areas. Rising groundwater levels could result in structural damage to foundations of historic structures in affected areas. Increased precipitation in arid areas would adversely affect adobe and other climate-sensitive materials.

Overall, the ecological and cultural heritage included in the National Park System, by any measure, ranks high on the list of resources at risk from the effects of global change.

Continued on page 7



The contribution *from each of the man-made greenhouse gases to the change in radiative forcing from 1980 to 1990. The contribution from tropospheric ozone may also be significant but it is difficult to quantify.*

GLOBAL WARMING POTENTIALS OF GREENHOUSE GASES RELATIVE TO CO_2

	Time Horizon		
	20 yr.	100 yr.	500 yr.
Carbon dioxide	1	1	1
Methane	63	21	9
Nitrous oxide	270	290	190
Chloro-fluorocarbons	4100-7100	1500-7300	510-4500

(Figures are best estimates calculated on basis of present day atmosphere.)

NPS Biogeographical Research Areas



This map illustrates *the location of the 11 biogeographic areas selected for inclusion in the FY 1991 Global Change Research Program. They are numbered as follows: 1, Colorado Rockies; 2, Florida Keys; 3, Glacier National Park Area; 4, Great Basin; 5, Northwest Alaska; 6, Olympic Peninsula; 7, Ozark Highlands; 8, Sonoran Desert; 9, Southern Blue Ridge; 10, Southern and Central Sierra Nevada; 11, Western Lake Forest. Number 12 indicates the location of the coastal barrier thematic program.*

Because we are a management agency and must manage in a biogeographic context, the NPS has adopted a biogeographic approach to its global change research tasks. Each of the biogeographic areas selected to prepare Global Change Operations and Conceptual Research Plans will build a program that addresses the basic scientific questions posed by the U.S. Global Change Research Program while also providing the basic understanding needed to develop adaptive management policies and programs.

Each of these programs will encourage interdisciplinary and interagency cooperation within the biogeographic area, as well as cooperation with research programs in other biogeographical areas and internationally on particular research themes. The thematic initiatives, which will be identified as the long-term program matures, will provide the basis for NPS scientific leadership.

Please turn to page 4.

The following section provides thumbnail sketches of global change research concepts being considered for inclusion in the NPS Global Change Research Program. A twelfth description is included for the coastal barriers thematic initiative.

Colorado Rockies. (core park: Rocky Mountain NP) The proposed program will follow an hierarchical approach, ranging from the study of global and regional effects of global change to those on the landscape and local levels. This global change research will utilize regional climate models to determine possible scenarios; these scenarios will then be used to predict ecological effects. An analysis of precipitation amounts, seasonalities, and intensities will be undertaken. A paleoecology component includes a study of historical records of debris flows. Additional studies will cover the impacts on lakes and streams, and vegetation changes due to changing characteristics and loss of soil.

Florida Keys. (core parks: Biscayne NP, Everglades NP, Fort Jefferson NM) The proposed program centers on the 200-mile-long Florida Keys coral reef track from Biscayne NP to Fort Jefferson NM. This program includes a study of the sensitivity of the corals themselves to factors associated with global change, such as temperature change and sea level rise, and will investigate the possibility of a drowning of the coral reef system due to sea level rise and potential adverse effects of increased water temperature. This research program will correlate the reconstruction of paleoclimates based upon records contained in coral, such as changes in salinity and deep water upwelling, with contemporary monitoring of regional sea water temperature, currents, and salinity. Studies of the effects of storm intensity on seagrass and coral reef productivity also have been proposed.

Glacier. (core park: Glacier NP) The proposed program has four primary components. Investigators plan to conduct a landscape analysis, with an emphasis on ecotones and shifting landscape patterns, and will study the diversity of topography and the possibility of rapidly shifting ecological boundaries. The alpine zone will also be studied; researchers anticipate that this zone may change dramatically, but are not certain yet *how* dramatic the change will be. A third component is watershed analysis, and a study of the links between weather patterns. A paleoecology component also is planned, including lake sediment analysis, tree ring coring, pollen profile analysis, and glacier coring, with the possibility of as much as a 12,000 year history.

Great Basin. (core park: Great Basin NP) The proposed program is primarily comprised of baseline monitoring studies. It will utilize a system of remote weather stations and an upgraded, Class I air quality monitoring station. Paleoecological studies (particularly dendrochronology) will be used as a tool for understanding the past and as clues to the future. The program will investigate relict species and biogeography, as well as plant community fluctuations, with respect to elevational gradients and Great Basin's location at the convergence of three weather systems. In addition, the Great Basin program will examine the chemical and biological sensitivity of small watersheds.

Northwest Alaska. (core parks: Bering Land Bridge NP, Cape Krusenstern NM, Noatak NP) The proposed program focuses on comparison of the impact of climatic change with other forces (e.g., herbivores, fire) on the sensitive resources of the Arctic regions. The program will include studies on response of the tree line to temperature change. The impact of global change on aquatics also will be investigated. With 27 percent of the world's soil carbon stored in Arctic peat soil and permafrost, the potential for mass release of carbon dioxide and methane into the water is significant. The program will monitor and study changes in this soil and permafrost. In addition, the potential implications of global change for native people will be studied.

Olympic Peninsula. (core park: Olympic NP) The proposed program concentrates primarily on subalpine and alpine environments. As the Olympic Peninsula has, within a relatively small area, some of the wettest and driest areas in the United States, changes in precipitation patterns and quantities and their relation to global change could have significant effects. Of particular interest is the physiological response of trees and other vegetation at high elevations and in old-growth forests to the effects of global change. The program includes research on global change effects on stream hydrology and chemistry. In addition, the program will examine the effects of changing environmental conditions on the physical and ecological processes associated with disturbances such as fire, avalanches, and glaciation.

Ozark Highlands. (core parks: Buffalo NSR, Ozark NSR) The proposed program concentrates primarily on aquatic resources. The effects of global change on the spring-fed aquatic systems of Ozark NSR will be compared with the effects on the precipitation-fed systems of Buffalo NSR. The correlation of red cedar chronology and stream flow regimes will be investigated, and the current records will be expanded to develop a model of the predicted effects of global change. The plants and animals of the Ozark springs, and the distribution and abundance of fish, will be studied to determine their sensitivity to global change. Social scientists will study potential effects on recreational uses, and construct correlative models using the "dust bowl" records of the 1930s.

Sonoran Desert. (core park: Organ Pipe Cactus NM) The proposed program studies how climate affects species distribution and structure in the desert environment. The investigators will integrate existing primary data sets into a geographic information system designed for the global change program. Specific activities include monitoring soil moisture and temperature and relating these properties to sensitive animal species such as the desert tortoise, and comparing remote Organ Pipe Cactus NM and urban impacted Saguaro NM for differences in ecosystem response to climatic change effects in an effort to factor out anthropogenic factors. In addition, researchers plan to experiment with environmental manipulation (e.g., "rain-out shelters") for modeling purposes.

Southern and Central Sierra Nevada. (core park: Sequoia-Kings Canyon NP) The proposed program focuses primarily on disturbance regimes in forested ecosystems, changes in the tree line ecotone, and global change effects on species such as the giant Sequoia that might ensue. This program will also study the tree line ecotone. Models will be developed to predict the types of changes that could be expected under varying climatic conditions. Investigators also plan to monitor what is happening today, such as studying reproductive modes and dispersal, so that climate change could be detected as it occurs. In addition, the study will focus on paleohistorical studies to provide data to test models of climate, disturbance, and biotic change.

Southern Blue Ridge. (core park: Great Smoky Mountains NP) The proposed program includes a characterization of selected sensitive ecological communities and species and their microclimates, and will attempt to correlate soil temperature and moisture regimes with the population dynamics of potentially sensitive species in old-growth forested watersheds. Also planned is a model to predict ecosystem destabilization associated with climate change, development of models of community distribution, watershed processes and response, and application of these models in Shenandoah NP and Great Smoky Mountains NP. The investigators plan to cooperate with the Southern Appalachian Man and the Biosphere Cooperative in studying human influences pertaining to global change.

Western Lake Superior. (core parks: Isle Royale NP, Voyageurs NP) The proposed program focuses on the fringe boreal forest of the Western Lake Forest



***Paleoarcheology** in relation to the Global Change program involves not only the saving and studying of prehistoric ruins but the investigation of how the inhabitants adapted to environmental conditions (and how, in some cases, they seem to have given up in the face of these changed conditions.) This is Inscription House Ruin at Navajo NM in Arizona.*

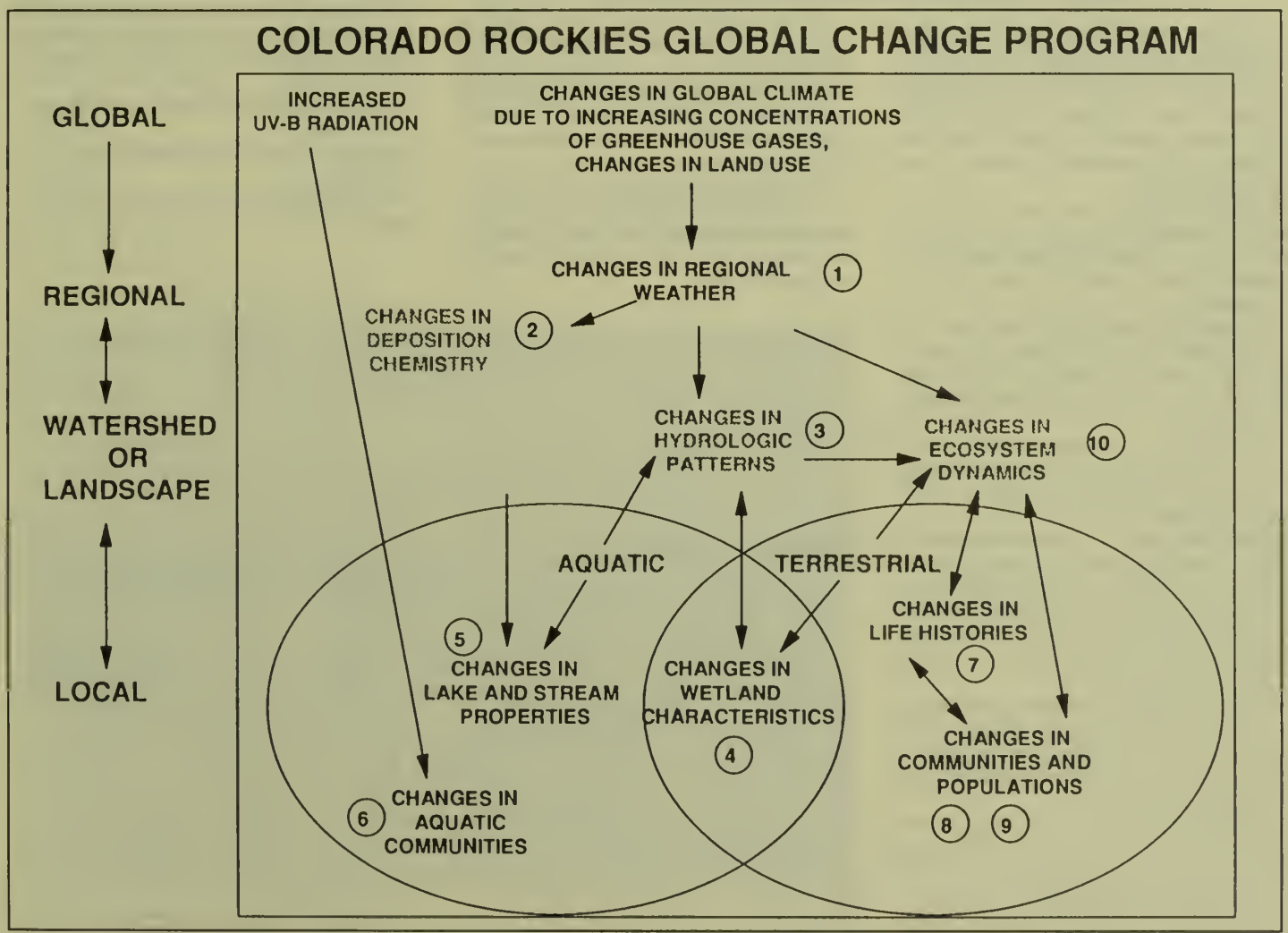


This erosion scene *(Cape Hatteras, March, 1973) will be repeated with increasing frequency up and down the nation's coastlines if ocean levels continue to rise and storm events intensify in numbers and strength.*

province, with emphasis on change in the nitrogen cycle as an early indicator of climate change. The program will involve contributing sites to the north and west of the core research areas to study the vegetation that may replace the boreal forest. Investigators plan to contribute to a multi-agency university study of the climate of Lake Superior, as well as to collaborate with the Canadian Park Service on boreal forest monitoring studies. The program also plans to institute studies on subsistence and small-scale economic fishing in Lake Superior and Canadian border lakes.

Coastal Barriers. The coastal barrier islands constitute one of the most dynamic natural systems within the National Park System. This thematic research program, which in FY 91 will focus primarily on the Mid-Atlantic NPS units, will be expanded in the out-years to include NPS units on the entire Atlantic and Gulf seaboard. The monitoring and research program will investigate the processes that are directly linked with the physical and biological systems that will respond to a change in climate; sea level, storm frequency and magnitude, air and water temperature, precipitation, and tidal wetland dynamics. Modeling and state-of-the-art GIS will be the foundation of this thematic research program.

An example *of the global change research concepts that will be considered for inclusion in the NPS Global Change Research Program is shown below.*



Numbers in circles *are hypothesis numbers which were discussed in the proposal.*



***Tree lines march** up and down mountain sides to the beat of changing climate regimes.*

Meet Pete Comanor

Peter L. Comanor, our new WASO Global Change Program Coordinator, took the reins of the Global Change Program from Bill Gregg on August 27. Pete, who comes from the Bureau of Land Management where he headed their Office of Budget and Management Support, has had a long and varied career, with positions ranging from twelve years at the University of Nevada at Reno to a Smithsonian assignment in Ceylon. Pete received his B.S. in Geology and his M.S. in Botany from Florida, and his Ph.D. in Ecology from Rutgers.

When Pete is not on the job, he enjoys visiting historic and natural areas, listening to music, and chores *(perhaps he could clean John Dennis's office!)* We look forward to having Pete on board. If you'd like to get a hold of him, he can be reached at (202) 343-8126 (FTS 343-8126).

Global Change Mitigation and Adaptation Research

The CEES is coordinating applied research relating to global change response strategies through the recently established Working Group on Mitigation and Adaptation Research Strategies (MARS). In July, the NPS forwarded concepts for 8 research initiatives to the Department for consideration in planning the interagency MARS program:

(1) Adaptive Resource Management in the NPS, a series of workshops and symposia to provide the scientific basis for developing management responses to the effects of global change on NPS natural and cultural resources;

(2) Vulnerability of Natural Ecosystems and Species, to develop information syntheses and methodologies for assessing potential risks to sensitive NPS ecological resources from hypothesized effects of global change.

(3) Biogeographic Cooperatives, to assess existing and potential cooperative mechanisms for addressing global change issues relating in particular biogeographical areas.

(4) Fire As an Adaptive Ecosystem Management Tool, to synthesize information on the relationship between pre- and post- fire climatological conditions and the course of ecological succession in selected biogeographical regions. The program would support adaptive management of vegetation under potential climate change scenarios.

(5) Risk Management on Coastal Systems, a long-term research and modeling program to support adaptive management of NPS coastal barriers under potential changes in sea level, and the magnitude and intensity and tracks of coastal storms.

(6) Adaptive Management of Public Recreation, to assess relationships between past short-term climatic changes and public recreational uses of National Parks to support contingency planning

(7) Adaptation of Small-Scale Societies, to utilize applied anthropology to assess adaptations of native and other small-scale societies to the potential effects of climate change

(8) Cultural Resource Preservation Research, to develop a strategy for adapting national preservation policy to respond to the environmental effects associated with global change.

The interagency MARS research program is still in the early planning stage. During the next year, emphasis is expected to be on interagency planning in preparation for implementing substantial research beginning in FY 1993.

For more information...

For more information, the following publications are recommended. A limited number of copies are available from David Figlio, WASO Wildlife and Vegetation Division, P.O. Box 37127, Washington, DC 20013-7127, (202) 343-8133.

Committee on Earth and Environmental Sciences, ***Our Changing Planet: the FY 1991 Global Change Research Program***. 1990. currently in draft, executive summary available.

Environmental Protection Agency, ***EPA Journal***, Jan./Feb. 1989.

Intergovernmental Panel on Climate Change, May 2, 1990 draft report.

National Science Foundation ***Mosaic***, Fall/Winter 1988.



***Recreationists** at **Assateague** Island National Seashore, along with NPS park-users everywhere, may find themselves having to make adjustments in their use patterns in response to management necessitated by climate changes.*

The NPS Global Change Research Program

By Bill Gregg, MAB Coordinator for NPS

To understand and address global change effects on ecosystem processes, and related effects on species distributions and life cycles, will require unprecedented cooperation at many levels: interdisciplinary cooperation among global change researchers; among research, educational, and management specialists in participating NPS areas; between these NPS specialists and others in the same biogeographic area; and among specialists in different biogeographical areas, including a strong emphasis on building international linkages. To foster the required multi-level cooperation, the NPS adopted the biosphere reserve model for developing its long-term global change research program.

In this model, a biogeographic area, defined on the basis of physical and biological factors and human-environment interactions, provides the geographic framework for developing cooperative programs. Each biogeographic area contains from one to several NPS units as core research areas that will serve as the

Continued on page 8

Continued from page 2

Policy Implications

A reading of the possible consequences of GCC will suggest immediately to resource managers the drastically changing nature of their responsibilities and tasks in the decades ahead. Policy issues, both near- and long-term, raise some interesting questions. The NPS will be concerned in a near-term context with such questions as:

(1) Under conditions of rapid habitat change, should NPS change its management philosophy of minimal intervention?

(2) How should climate uncertainty be incorporated into NPS planning activities?

(3) Should NPS become a more active cooperator in maintaining ecosystems outside park boundaries?

(4) What should be the NPS role in generating scientific information for detecting, understanding, and predicting global change effects?

(5) To what extent should NPS educate the public on the effects of global change?

Longer-term policy issues give rise to a different set of questions:

(1) Should NPS adopt a policy of active vegetation management?

(2) Under what conditions should NPS participate in national or international efforts to rehabilitate degraded ecosystems?

(3) To what extent should NPS encourage *ex situ* maintenance as a means of perpetuating native species?

(4) Under what conditions should the NPS intervene to prevent, mitigate, or lessen the effects of sea level rise?

(5) To what extent should potential sea level rise and climate change be considered in NPS land purchases and boundary modifications?

How Does The U.S. Fit Into the World Research Picture?

The U.S. Global Change Research Program is coordinated by the Working Group on Global Change of the interagency Committee on Earth and Environmental Sciences (CEES). The overall goal of the U.S. Program is to "establish the scientific basis for national and international policymaking relating to natural and human-induced changes in the global Earth system."

In the executive summary of ***Our Changing Planet: The FY 1991 Research Plan of the U.S. Global Change Research Program***, the CEES underscored the Administration's commitment to improving our understanding of the process and implications of global change:

"Recognizing the profound economic and social implications of responding to global environmental changes, the President has set in motion a comprehensive process designed to continue U.S. leadership on this issue. This includes an accelerated, focused research effort; active participation in international collaborative efforts intended to culminate in a Framework Climate Convention; and a comprehensive review of potential policies and their implications.

"As the research component of this process, the U.S. Global Change Research Program is designed to reduce key scientific uncertainties and to develop more reliable scientific predictions, especially predictions of changes in regional climate, upon which sound policy strategies and responses can be based."

The CEES has structured the U.S. research program around seven interdisciplinary science elements:

- Climate and Hydrologic Systems
- Biogeochemical Dynamics
- Ecological Systems and Dynamics
- Earth System History
- Human Interactions
- Solid Earth Processes
- Solar Influences

The CEES has established technical Task Forces to coordinate interagency programs under each science element, and additional task forces to coordinate activities in the areas of modeling, data management, international coordination, industry and global change science, outreach and communications, and education and training. NPS specialists are participating on 11 of the CEES Task Forces.

NPS Research Categories

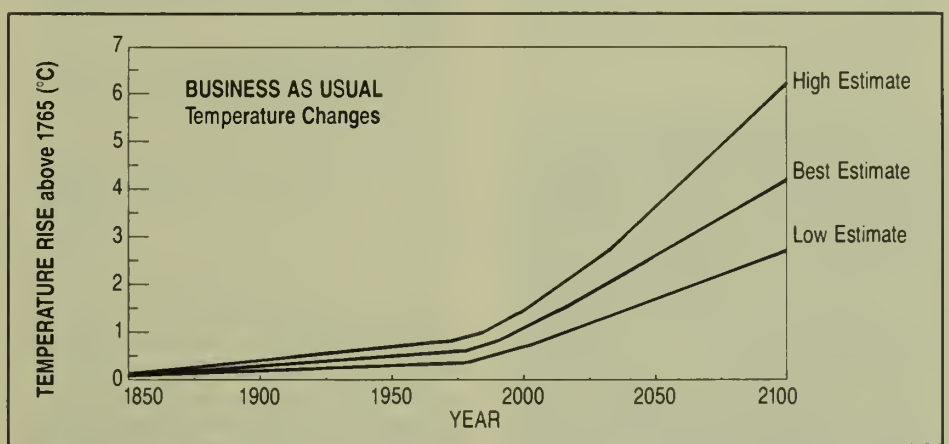
The National Park Service will be conducting global change research within four of the seven interdisciplinary science elements designated by the CEES.

Under Ecological Systems and Dynamics, the NPS will conduct studies to understand the global change interactions at the population, community, watershed and landscape levels.

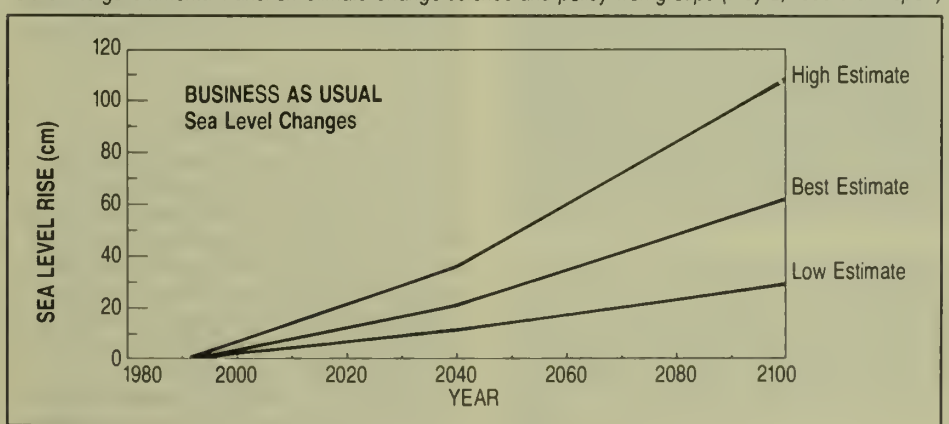
Under Earth System History, NPS will be conducting a variety of paleostudies to provide evidence of past climate change and its effects.

Under Human Interactions, our resource ethnography program will look at the effects of climate change on subsistence and other ecosystem uses of native and other small-scale societies.

And finally, under Solid Earth Processes, we will study the dynamics of coastal systems as affected by sea level rise and changes in the frequency, intensity, and tracks of coastal storms, with emphasis on NPS coastal barriers.



***Projected temperature rises** (above) and sea level rises (below) shown here represent best estimates according to the Intergovernmental Panel on Climate Change science and policy workgroups (May 2, 1990 draft report).*



Research Program

(Continued from page 7)

primary NPS sites for developing coordinated long-term interdisciplinary research programs. The core research areas are either designated units of the UNESCO's International Network of Biosphere Reserves, currently under study, or are considered potentially suitable for designation.

Contributing Areas

In addition to the core research areas, other NPS units in the biogeographic area will serve as contributing areas. The contributing areas will provide study opportunities by virtue of additional data sets through cooperative monitoring and research, and from natural or cultural resources not present in the core research areas. The participating NPS units in each biogeographic area will develop their research programs to address the scientific priorities identified by the CEES in the U.S. Global Change Research Program, while also providing the basic understanding needed to develop adaptive management policies and programs.

Each program will encourage interdisciplinary and interagency cooperation within the biogeographic area, as well as cooperation on particular research themes with other biogeographical areas and internationally. These interregional and international thematic initiatives, which will be identified as the long-term program matures, will provide the basis for NPS scientific leadership in the global change program.

The Review Process

The NPS Global Change Program is based on a process of concept development, program formulation, development of research proposals, and progressive strengthening of operational capabilities in participating field units. The NPS process relies strongly on review of the program and individual research proposals by NPS and outside specialists using key CEES criteria (relevance to global change program objectives, scientific merit, readiness, linkages, enhancement of existing program research). Higher level reviews of the NPS program by the Department of the Interior and the CEES Working Group on Global Change will also use these criteria and will facilitate coordination among Departmental bureaus and with other agencies. These reviews will maintain a high degree of accountability within the Global Research Program.

The Invisible Present

"All of us can sense change – the reddening sky with dawn's new light, the rising strength of lake waves during a thunderstorm, and the changing seasons of plant flowering as temperature and rain affect our landscapes. Some of us see longer-term events and remember that there was less snow last winter or that fishing was better a couple of years ago. But it is the unusual person who senses with any precision changes occurring over decades. At this time scale, we are inclined to think of the world as static, and we typically underestimate the degree of change that does occur. Because we are unable directly to sense slow changes and because we are even more limited in our abilities to interpret their cause- and-effect relations, processes acting over decades are hidden and reside in what I call 'the invisible present.' "

John J. Magnuson, in ***BioScience***
July/August 1990, p. 495

The Invisible Place

"...lack of historical perspective can place short-term studies in the 'invisible present,' where a lack of temporal perspective can produce misleading conclusions. Similarly, the broad significance of research results from a particular site is difficult to interpret if the site's context in space (e.g. location within region-scale variation in disturbance regime and temperature-moisture conditions) is not understood. In this sense, an isolated research site may reside in an 'invisible place' where the significance of results is unclear."

Frederick J. Swanson and Richard E. Sparks
In ***BioScience***, July/August 1990, p. 502

The NPS global change program began with the Secretary's establishment of the Departmental Working Group on Global Climate Change (DWGCC) in November 1988, to provide a framework for interagency cooperation in response to CEES priorities. In early 1989, the DWGCC asked each bureau to identify ongoing research programs relevant to the U.S. Global Change Research Program. Bureaus were asked to provide information on "focused" programs targeted and justified to address global change research issues, and "contributing" programs relevant to global change research but justified on other grounds. (Focused programs are funded as components of the interagency U.S. Global Change Research Program; contributing programs are funded through other sources).

Through the Department's initiative, the CEES recognized 17 NPS programs under 5 science elements as contributing programs in the FY 1990 U.S. Global Change Research Plan, published in July 1990. The initiative established the relevance of NPS and other bureau research programs to the global change issues, and provided the opportunity to develop a focused program.

Coordinator Appointed

The NPS Director appointed Eugene Hester, the Associate Director, Natural Resources (ADNR), as the responsible NPS official for developing the NPS program. Dr. Hester designated Dr. William Gregg, the Service's Man and the Biosphere Program Coordinator, to coordinate technical aspects of the NPS program within the Service and with the Department and various CEES scientific Task Forces. Dr. Gregg served in this capacity until the appointment of Peter Comanor as full-time NPS Global Change Coordinator in August (see p. 6).

Through an informal network of WASO and field scientists, the NPS developed proposals for a cooperative integrated program of ecological research in selected biogeographic areas, to serve as the major NPS program emphasis, and a small thematic program to study global change effects on coastal systems. The "integrated studies" proposal called for initiating research in 12 biogeographic areas in FY 1991 and the addition of two biogeographic area programs annually until achievement of the full performance level of 20 biogeographic area programs in FY 1995.

As a result of the coordination between the Department, the CEES, and the OMB, the programs were included, albeit at a somewhat reduced funding level ($3 million and 26 FTEs), in the President's FY 1991 budget request to the Congress.

In February 1990, following release of the Administration's budget request, the Director announced the NPS Global Change Research Program; authorized an NPS program committee to plan, coordinate, and oversee the program; and invited parks interested in being considered as core research areas to prepare statements on their research capabilities and interests in global change research.

The Selection Process

NPS units representing 27 biogeographic areas prepared written statements, which were presented orally to the program committee and a group of outside reviewers at a workshop in New Orleans in May. Based on the review group's comments and the program development considerations, the NPS Global Change Program Committee (GCPC) recommended, and the ADNR approved the recommendation, that NPS units in 11 of the biogeographic areas be invited to prepare Global Change Operations and Conceptual Research Plans (GCPs) for participation in the NPS Integrated Studies program, and that planning also be initiated for thematic research initiatives on the effects of global change on coastal barriers and glaciers. Each park that submitted a proposal received feedback from the peer reviewers and the program committee for consideration in preparing their plans or, for the areas not selected, in deciding whether to revise their concept statements for consideration in the planning and review process for the FY 1992 program cycle.

Contributions of Long-Term Research

"Research with an extended time perspective is crucial if one accepts the premise that long-term phenomena have a central role in ecological science. Such studies are uncommon despite this obvious need and repeated evidence of the misleading nature of short-term research. Factors contributing to the rarity of long- term studies include difficulties in obtaining sustained financial support and in providing continuing leadership."

Jerry Franklin, Caroline Bledsoe, and James Callahan
In ***BioScience***, July/August 1990, p. 509

Plans for the FY 1991 programs are due to the ADNR by October I, 1990. The plans will be reviewed by outside scientists. In late October, the program committee meets in Seattle to review the plans and the peer review comments, and to recommend personnel and funding allocations for program operation and which research concepts will be developed as full research proposals.

Following the ADNR's approval of the Plans, the core research areas with approved Plans will develop the detailed research proposals and secure outside peer review. Final proposals and accompanying peer review comments must be submitted to the ADNR not later than March I, 1991. The GCPC will then be asked to review the research proposals and make recommendations to the ADNR by late March. The ADNR will select proposals and complete the allocation of GCP funds by early April 1991.

information crossfile

Archeologist Robert S. Carr, who directs the nonprofit Archeological and Historical Conservancy in Miami, FL, told ***Science News*** (July 7, 1990) that the nearly 40 "earthworks" dotting the landscape of southern Florida's interior may represent North America's earliest known fisheries. John Griffin, retired chief of the NPS Southeast Archaeological Center in Macon, GA, agrees with Carr's interpretation.

The prehistoric network of circular canals and earthen mounds – most discovered by Carr since 1974 – date to as early as 450 B.C. Others originated in the 16th century. The carefully engineered structures indicate that prehistoric hunter-gatherers inhabiting inland regions of southern Florida developed socially stratified societies based on fish harvesting, according to Carr. An agricultural way of life generally is thought to be essential to the rise of social classes, but anthropologists have long noted that Indians along Florida's southern coast developed all the trappings of stratified societies although they hunted and fished instead of planting crops. Carr suggests that their social elite coordinated construction of fish harvesting sites.

⁂

An invention about to be tested at sea promises a view of marine life that until now has been hidden beneath the waves, according to newswire reports that moved around July 19, 1990. The system combines newly developed sonar techniques and advanced computer processing to produce three-dimensional images of ocean animals and their activities.

Jules S. Jaffe of the Scripps Institution of Oceanography in La Jolla, CA, inventor of the system, has received a federal grant to test it at sea as part of a large-scale research program called Global Ocean Ecosystem Dynamics. He expects it to provide researchers with a better understanding of marine animals as they react to one another and to environmental changes.

⁂

While the Northern spotted owl and the timber industry square off against each other in the Pacific Northwest, a 3-pound rodent known as the Mt. Graham red squirrel is holding up construction on Mt. Graham of seven large telescopes – the dream of astronomers at the University of Arizona in Tucson in collaboration with the Vatican and the Max Planck Institute for Radioastronomy in Bonn, Germany. The clarity of view and isolation from light pollution have prompted astronomers to call Mt. Graham one of the premiere U.S. outposts for observing the heavens.

According to a report in the July 7, 1990 issue of ***Science News,*** the General Accounting Office (GAO) has found "serious flaws" in a 1988 report by the USFWS, which concluded that Mt. Graham's Emerald Peak is one of two "reasonable and prudent" sites for the telescopes. Although GAO has recommended updating the report, confusion exists as to who can order such an update, under the Endangered Species Act. According to the Act, only the USFS can order such an update. Meanwhile, if delays continue, the University frets that its partners "may pull out."

⁂

In 1988, Lois Winter, an NPS interpreter, opted to take a two-year leave of absence to return to graduate school and complete a two-year NPS field research project aimed at bridging the communication gap that she felt exists among NPS interpreters, resource managers, and researchers.

In April, 1990, she wrote an article on the subject that has been accepted by the NPS's ***Interpretation.*** She did her work with the help of a Horace Albright research grant and earned a Master's in Wildlife Conservation. Her field research was at Acadia NP.

Her four recommendations, (the guidelines for accomplishing them appear in her ***Interpretation*** article) are:

1. Designate a "research liaison" in the Interpretive Division of each park, with the formalized duty of forging an effective link between resource managers, researchers, and interpreters.

2. When drafting research proposals, Regional Office Science Divisions should incorporate specific requirements to assure that park interpreters have access to important information from researchers.

3. Because research may have significance in parks other than the one where it was carried out, every Regional Chief of Interpretation should stay in touch with the Region's Chief Scientist. By maintaining a basic awareness of ongoing nationwide NPS research, the Regional Chief of Interpretation can alert each park's "research liaison" of potentially relevant research elsewhere in the NP System. The liaison persons in the parks can pursue worthwhile leads by communicating directly with the appropriate parks.

4. To emphasize its importance, incorporate a section in the Statement for Interpretation detailing interesting research results and describing progress and stumbling blocks in establishing and maintaining the interpreter-researcher connection.

Lois suggests that "only when visitors understand the critical problems that threaten park resources can we expect them to play a role in minimizing those problems. Interpretation is a vital tool in focusing attention on resource issues the confront the parks.

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"Black Bear Population Dynamics in Yosemite NP" is the title of Technical Report #39, by Jeffrey A. Keay, in the U/CA/Davis CPSU publication series. The 138-page document consists of 3 indendent papers written for publication in scientific journals, plus a management summary and specific recommendations for Yosemite NP. Sex and age composition and reproductive rates of nuisance black bears *(Ursus americanus)* were examined from 1984 through 1988 in Yosemite NP to assess the effects of an intensive bear management program. A matrix population model was used to evaluate the relative importance of survival and reproductive rates to population growth rate and age structure and the population's ability to withstand the impacts of intensive management.

Obituary

The Region is saddened to report the death of John Dalle-Molle, for many years the Resource Management Specialist at Denali NP and for the last two years of his life at North Cascades NP. Dalle-Molle, who died June 10, 1990, had a wide range of specialties, including bear management, fire management, natural resource management, revegetation/restoration, subsistence uses, and wildlife management. The Region will sorely miss his services.

The ***Natural Areas Journal*** (Vol. 10 (2), 1990) features an article dealing with "A Synthesis Approach to Research and Management Planning: The Conceptual Development and Implementation," by Allen Steuter and Carolyn E. Grygiel of The Nature Conservancy and Mario Biondini of the North Dakota State University's Animal and Range Sciences Department. Starting from the premise that natural area management at the landscape level implies an understanding of the interactions among ecological forces, and that these interactions can be better understood by an a priori synthesis approach during the development of a management plan, the authors describe a stewardship strategy for mixed prairie preservation. The synthesis approach is used to restore the fire/bison grazing/pocket gopher disturbance interactions to a grassland ecosystem, starting with a conceptual model of a natural area, and proceeding through a hypothesis that the patch dynamics of grassland ecosystems is a hierarchical process organized at different spatial and temporal scales. Findings led to the conclusion that management actions that are independent of landscape context will limit the structure and function of the native communities these actions strive to preserve.

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People looking for new job opportunities are reminded that the Student Conservation Association, Inc., of Charlestown, NH 03603, publishes a monthly listing of permanent, seasonal, and internship openings in its ***Job Scan*** magazine. The SCA phone number in Charlestown is 603/826-4301.

⁂

The discovery of a second marbled murrelet nest in a stand of old growth timber in Oregon's Coast Range was made on July 12 in a Douglas fir tree on BLM land, about 20 miles inland from the Pacific coast. The tree was 4 feet in diameter at its base and more than 160 feet tall, according to the BLM, which announced the find. Nelson found the first Oregon nest on May 18. One other murrelet nest – in Washington – brings to 3 the total number of such known nests in the Pacific Northwest.

⁂

"Professors' poor prose poses perplexing problem"is the headline on an ***L.A. Times-Washington Post News Service*** story by Thomas V. DiBacco, a historian at the American University in Washington, DC and author of a high school history textbook. His thesis: "Increasing numbers of professors can't write well."

"Verbosity and pomposity" on the part of professors, DiBacco writes, has lately been exacerbated by "muddled prose." He cites this example, taken from a learned statement on contemporary challenges in higher education:

"But having a focused purpose in mind helps it continually prioritize its goals and objectives within the cross-currents of issues and new circumstances that continually pound on it."

An individual who cannot write clearly (and serve as a model for his students) "is uneducated," says DeBacco, "no matter the credentials." He concludes that professors would do well to heed the words of Francis Bacon, who wrote in 1625: "Reading maketh a full man, conference a ready man, and writing an exact man."

Nature Reserves: Island Theory and Conservation Practice, by Craig L. Shafer, ecologist with the NPS Washington Office, will be published by the Smithsonian Institution Press in October 1990. The island biogeography theory is controversial, and Shafer reviews the literature on this and related subjects, then synthesizes some guidelines for dealing with these theories. His analysis includes ecology, biogeography, evolutionary biology, genetics, and paleobiology, as well as legal, social, and economic issues. The roadmap thus provided through this complicated body of literature is meant for biologists, students, nature reserve managers and planners, and others with conservation responsibilities.

The 208-page book contains 58 black and white illustrations. Clothbound copies will be $39.95; paper, $15.95.

⁂

Madras Plenary Session, the final consensus report of the Keystone International Dialogue Series on Plant Genetic Resources, is now available through the Keystone Center, PO Box 606, Keystone, CO 80435; 303/468-5822. The session was held from Jan. 29 through Feb. 2, 1990, in Madras, India, with 46 individuals from 26 countries taking part. The Dialogue Series involve participants from non-governmental organizations, national governmental organizations, corporations, research institutions, and international and intergovernmental organizations from developed and developing countries.

The recommendations of this Dialogue were formulated with an eye to their usefulness at the June 1992 UN Conference on Environment and Development, to be convened by the UN in Brazil and to focus on issues such as the conservation of biological diversity, the potential of biotechnology, protection of the atmosphere, and protection and management of land resources.

Copies of the ***Madras Plenary Session*** also are available from ***Diversity,*** the quarterly news journal for the plant genetic resources community, at 727 8th St. SE, Washington, DC 20003; (202) 543-6843.

⁂

Islands Under Siege: National Parks and the Politics of External Threats is the title of new 200-page book by John C. Freemuth, assistant professor of political science and public affairs at Boise State University. He has served on advisory panels for the NPS.

If the Park Service can't – or won't – protect our national parks, who will? he asks, and adds, "It's high time we figure that out." Freemuth first examines the "administrative tightrope" the Service has had to walk, "saddled from the beginning with a contradictory mandate – to promote recreational use of parks yet preserve them for future generations." The new crop of threats – environmental degradation from sources outside the parks – Freemuth sees as political problems. He traces the shifts in government action that have accompanied waves of citizen activism and uncovers evidence of ineffective legislation, inept implementation, and the potent political power of pro-development forces. His conclusion analyzes a set of political strategies that have been used to deal with these threates, evaluating each in terms of environmental effectiveness and political feasibility. The clothbound book (ISBN 0-7006-434-0) has nine photographs, five 6x9" maps, and costs $25.

Oregon State University researchers report finding that many of the shrubs and trees in a massive area of southwest Oregon and northern California actually depend upon water drawn from solid rock by tiny roots deep in stone. Their study, which suggests that millions of acres of vegetation would be near desert without the plants' ability to extract water from more than 10 feet deep into seemingly impenetrable stone, could dramatically alter conventional wisdom about growth patterns and characteristics of many plants in a wide area of the western United States.

Michael Newton, a professor of forest science, describes finding that "after certain shrubs or trees are a few years old, they can and do draw 70 to 80 percent of their water from roots in bedrock during the summer months." Highly competitive shrubs such as manzanita have among the most vigorous capability to send minuscule roots about the thickness of a thread into rock cracks a few thousandths of an inch wide. After a heavy rain, soils can contain from 10 to 35 percent water, Newton said. The typical density of rock is about double that of soil, and rock has fewer pores, but different types of rock can hold from 12 to 22 percent water, and plants may be able to tap into as much as half of that liquid reservoir, the study indicates.



Tiny hairlike roots *are shown here growing out of solid rock excavated from about 10 feet below ground surface. They are seen in this close-up photo in comparison with the point of a pair of tweezers.*

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First there was acid rain, which tends to render lake waters sterile. Now comes "the green hand in the sea," which is Victor Smetacek's name for too much fertility. Smetacek is a marine bioligist at the Alfred Wegener Institute for Polar and Ocean Research in Bremerhaven, Germany, and he is quoted in the April 1990 issue of ***Science,*** under a Berlin dateline in the News & Comment section.

The most visible manifestations of that green hand are the red tides, yellow foams, and outbreaks of clinging emerald slime that constitute phytoplankton blooms, says the article. On a small scale, such blooms are part of the natural cycle of the sea, but by supplying extra nourishment, human activities probably have upset this orderly round in many parts of the world. Smetacek has compiled a casebook of "exceptional phytoplankton blooms,"all increasingly toxic" and spelling death for much of the life in the oceans' margins, where 30 percent of the seas' productivity occurs.

At the Ocean Margin Processes in Global Change workshop, held in Berlin March 18-23, 1990, there was strong consensus that whether these conditions reflect global changes or not, there are things going on in ocean margins around the world that will have critical consequences – and soon.

Park Science has been reporting sporadically, as the isolated incidents made the news, on the mysterious disappearance of amphibians. Now Michael Milstein, reporter for the ***Billings Gazette,*** and a former NPS ranger, does a thorough job for the National Parks and Conservation Association's magazine, ***National Parks,*** (July-August 1990) of uncovering what is happening to these little noticed denizens of the National Park System. He interviews a cross section of scientists as to possible causes and prognoses. "There are few reassuring signs," he notes. "What is most urgently needed now, biologists say, is research to prove exactly what is killing frogs and their kin. Backcountry rangers working in several NPs, including Canyonlands, Yosemite, and Sequoia, will be on the lookout for healthy amphibian populations this summer."

UCLA Biologist David Bradford mourns the "anecdotal" nature of much of what is now known. Last summer, Bradford found frogs in only one of 46 Sequoia NP ponds where he had studied them in the 1970s.

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A handsome, hardback, 163-page volume, ***Interdisciplinary Approaches to Freshwater Wetlands Research,*** edited by Douglas A. Wilcox and published by the Michigan State University Press, East Lansing, is Volume 7 of a series resulting from the 1986 Conference on Science in the National Parks. The 11 refereed papers by 20 contributors were specifically invited by Dr. Wilcox so that they covered many of the interactions among the various disciplines used in wetlands research.

Wilcox's present address is USFWS, National Fisheries Research Center-Great Lakes, 1451 Green Road, Ann Arbor, MI 48105.

⁂

From David Manski, at Cape Cod NS, comes word of a new USFS publication of possible interest to ***Park Science*** readers. ***Management of Amphibians, Reptiles, and Small Mammals in North America*** is the Proceedings of a July 1988 symposium held in Flagstaff, AZ. The 450+ paged document ranges from the overarching general (Historical Perspective and Objectives, and The Need for an Environmental Attitude) to the extremely specific (e.g. The Herpetofaunal Community of Temporary Ponds in North Florida Sandhills). Writes Manski: "I got my copy free from the USFS, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect St., Fort Collins, CO 80526-2098.

Wilderness Proceedings

Managing America's Enduring Wilderness Resource documents the proceedings of the conference by the same name held Sept. 11-17, 1989, in Minneapolis and northern Minnesota in commemoration of the 25th anniversary of the 1964 Wilderness Act and establishment of the National Wilderness Preservation System. The book provides a forum for discussion on how best to protect that System through creative management. Most of the conference presentations are included in this 700-page book. Copies can be ordered from University of Minnesota, Distribution Center, 3 Coffey Hall, 1420 Eckles Ave., St. Paul, MN 55108 for $32.50, including shipping and handling.

Mercury Contamination: Another Threat to the Florida Panther

One of the nation's most critically endangered animals, the Florida panther *(Felis concolor coryi)* is believed to number only 30 to 50 animals in the wild, according to an Endangered Species Technical Bulletin by Dennis Jordan, Florida Panther Coordinator for the USFWS's Florida Cooperative Fish and Wildlife Research Unit.

The bulletin (Feb. 1990, Vol. XV No.2) ascribes the subspecies' decline to habitat loss, a reduction in the prey base, and the killing of panthers by people. But it also notes that recent information indicates an additional serious threat: contamination from mercury, a toxic metal. Extremely high levels of mercury – over 100 parts per million – were found in the liver of a panther that died in the Everglades last summer. Until her death in July 1989, the 4-year-old female (known to researchers as #27) had been radio-tracked by Everglades NP daily for about 15 months.

The current US Food and Drug Administration's action level for mercury in fish is 1.0 ppm; concentrations as high as 4.4 ppm have been documented in largemouth bass *(Micropterus salmoides)* fillets from sites in southeast Florida. Samples from one section of Everglades NP exceeded 1.5 ppm.

Concern is focusing on finding the source of the mercury contamination in Forida, where the usual sources (pulp and paper mills, coal-fired power plants, etc.) do not figure. According to Jordan:

"While no generally accepted explanation has surfaced, a hypothesis was suggested in a December 1989 report released by the Technical Subcommittee of the Florida Panther Interagency Committee [on which NPS representatives serve]. Its report suggests that the mercury could be coming from a natural source: the peat and muck soils that are common throughout Florida. These often flooded and highly anaerobic soils provide a suitable environment for the methylation of inorganic mercury.

"Methylmercury, a product primarily of anaerobic bacteria, is the biologically active and toxic form of mercury; inorganic mercury, on the other hand, is considered to be biologically innocuous. The slow oxidation of peat and muck soils by burning, draining, or other disturbances, provides an avenue for methylmercury to enter the food web, where this contaminant accumulates in the predators of aquatic animals. While no research has yet been conducted in Florida to verify this hypothesis, studies in Finland – a country with one-third of its land covered in peat soil – have traced mercury contamination to various types of surface disturbances."

Studies of the remains of #27 and other archived dead panthers have caused the Technical Subcommittee to conclude that mercury contamination of the panther is potentially a serious threat. None of the mercury levels documented in the other dead and live panthers analyzed were as high as those in #27, still some were at levels high enough to be of concern.

The Subcommitte also concluded that the Fakahatchee Strand and East Everglades areas appear to be hot spots for mercury contamination of panthers. The presumed source is the panthers' prey – particularly raccoons, which bioaccumulate mercury through the aquatic food web. Mercury contamination is also suspect as the culprit in the lower reproductive success of female panthers in areas where small prey is the predominant food source.

The Panther Interagency Committee in January 1990 recommended acceleratioon of the routine testing of panthers in the wild, establishment of an action level of 1.4 ppm for whole blood in panthers, action to better identify problem areas and contaminated prey resources, and increase of uncontaminated prey through habitat management and harvest regulations. The Committee also recommended screening panthers for other potential pollutants, including other metals, organochlorines, and PCBs, and supporting efforts to identify and rectify the source of mercury contamination.



***The Florida panther** once occurred throughout Florida and from eastern Texas or western Louisiana through Arkansas, Mississippi, Alabama, Georgia, and parts of Tennessee and South Carolina. Today it is believed to survive only in remote parts of south Florida.*

Stephen Nodvin, who heads the NPS/CPSU at UTN, writes from long and intensive experience with long-term research programs. His views on the NPS Global Change initiatives are strongly held and forcefully expressed in an article in the next George Wright Society ***Forum,*** Vol. VII No. 2, scheduled for publication prior to the Nov. 12-17 Conference on Research in the National Parks and Equivalent Reserves, El Paso, TX.

On May 18, 1990, a newly radio-collared male Florida panther in Everglades NP was found dead from a chest infection, apparently caused by accidental puncture by a stick. The only remaining male in the park is closely related to the only two female panthers.

Natural Resource Management At Colonial National Historical Park

By Chuck Rafkind

Colonial National Historical Park (NHP), established in 1930 to preserve the historic resources of Jamestown Island and Yorktown Battlefield, also possesses significant natural resources – worthy of an active natural resource management program. These include extensive tidal and non-tidal wetlands (about 2,000 acres), forest (nearly 8,000 acres), and open fields (about 1,000 acres); 40 miles of streams and James and York River shorelines, and rare, threatened and endangered (RT&E) flora and fauna. Two sizeable units comprise the park: Jamestown Island (1,500 acres) and Yorktown Battlefield (4,300). The units are connected by a 23-mile parkway (3,600), and there are four small, noncontiguous areas: the Cape Henry Memorial, Swann's Point, Green Spring Plantation, and Tindall's Point. Most of the park lies adjacent to the James or York rivers.

In addition, various cultural resource activities involve natural resource processes and techniques. In the light of all this, the park has joined with several outside organizations to conduct in-park research aimed at insuring protection and proper management. These include Virginia's Water Quality Board, Department of Game and Inland Fisheries, Natural Heritage Program, and Department of Forestry; the US Geological Survey, the US Soil and Conservation Service, the USFWS, Virginia Institute of Marine Science, the College of William and Mary, and Hampton University.

With NPS Regional science and Air Quality Division assistance, we are developing a management plan that describes the park's air quality related values and recommends proposals for monitoring of ozone, sulfur dioxide and visibility; acid deposition and its impacts of park structures, vegetation and aquatic environment; and air pollution impact on vegetation. An air quality bio-monitoring program will begin in 1991.



***This distinctive art** was created by Yorktown District Interpreter Doug Thompson, to be used as the cover for the park's Resource Management Plan. The design integrates the significant cultural and natural resources of Jamestown Island and Yorktown Battlefield.*

Erosion Control

Personnel from all park divisions have helped design and implement management actions to control erosion on numerous informal trails along the Yorktown bluffs. These bluffs contain the remains of the British (1781) and Civil War earthworks. Trails connecting the bluff and the river have developed serious erosion problems from social usage, combined with the natural sloughing action of the bluffs. Management actions emphasize the use of natural vegetation barriers, including the planting of native bushes, no-cut zones for adjoining open fields, repairing and expanding present fencing and signing. Interpretive actions will include on-site messages, new exhibits, public service announcements to local TV and radio stations, press releases to local and regional newspapers, and orientation for park employees. Also planned is social science research to determine who the trail users are and what are their needs.

A fire management plan emphasizes suppression of fires on park lands and stresses improved coordination with adjoining fire fighting organizations.

The park is working with the State Forester, the Agricultural Extension Agent, and the new Regional Soil Conservationist on a plan for environmentally and economically sound management of the extensive open fields in the park. Erosion control, weed control, forestry practices, alternate mowing regimes, farming, water quality management, all are being examined.

A change in the mowing regimes of open fields around Yorktown Battlefield and Colonial Parkway has meant that a number of intensively mowed fields now will be maintained as tall grass fields. It is expected that this will help reduce the number of illegal paths along the Yorktown Bluffs and earthworks. Some fields will be mowed only once a year. Across one field, a path will be mowed to permit easy visitor access from the Yorktown Visitor Center to British Redoubt #9. The mowed path can be changed periodically to limit impact to any one area of the field. Another expected bonus from curtailed mowing will be the abundance of wildflowers it will allow. This selected mowing regime, subject to adjustment, may be extended along the 23-mile Colonial Parkway, providing improved erosion control along the James and York rivers, which flow into Chesapeake Bay.

RT&E Flora and Fauna Survey

The State of Virginia's Natural Heritage Program is conducting an RT&E flora, fauna, and critical natural community survey of all NPS areas in the state. The data thus gathered will aid park planning and management efforts to preserve biological diversity. Also the study will recommend guidelines for management of the RT&E species and critical habitats of the park. Next to Shenandoah NP, Colonial has the highest number of RT&E species of any NPS site in Virginia.

The Cartographic Computation Lab at NC/State/U is assisting the park in developing a Geographic Information System. Aerial (winter, true color) photographs taken in 1989 are being interpreted and digitized in developping the following themes at a scale of 1:12,000: Current vegetation, wetlands, streams, ponds, earthworks, roads and trails, and adjoining land ownership use types (residential, military, commercial).

These data bases are being used to (1) identify fire management units and prepare fire fuel and National Fire Danger Rating System models, (2) compare historic and current vegetation patterns, (3) prepare park boundary maps delineating adjoining lands that could be developed under the Chesapeake Bay regulations and their impact on the park viewshed, and (4) develop environmental assessments and aid in the review of adjoining land use proposals.

Water Resources Management Plan

We are working with the Regional Chief Scientist,

Vegetation Management in Great Basin NP

By Raymond Jaindl, Lee Eddleman, William Brock and Boyd Byelich

The Great Basin province is a mixture of high desert basins alternating with a series of nearly 200 isolated, long, narrow, north-south oriented mountain ranges created by major block faulting. Great Basin NP (GRBA), in the South Snake Range of east-central Nevada, rises nearly 8,000 feet from the valley floor to the top of 13,063 foot Wheeler Peak. It contains a diverse flora, ranging from desert to arctic alpine above tree line.

Many of the potential natural communities found in the Great Basin Province were a complex of plant community types, the result of disturbances such as fire and drought. These events were cyclical, with natural successions occurring during interims that varied from 40 to more than 100 years, depending on the community. By the early 1880s, livestock grazing was being introduced to the Province on a first-come, first-served basis, with no restrictions to prevent overgrazing. Fire, believed to be a natural component of many of the potential natural communities in the Great Basin Province, was greatly reduced during this period because the fine fuels (grass) needed to carry fire were removed by grazing. Consequently, plants susceptible to fire but not used as livestock forage established and expanded their ranges.

Livestock numbers in Nevada have declined from a high of 1.2 million sheep and 500,000 cattle in 1918 to 93,000 sheep and 383,000 cattle today. The fire-carrying fuels have increased with the decline in livestock numbers and with improved rangeland management. However, a continuing policy of fire suppression has essentially eliminated fire.

Continued from page 16

the NPS Water Resources Division, Virginia Polytechnic Institute, and State University Water Resources Research Center to develop a parkwide water resources management plan. The plan will (1) complete the delineation of park non-tidal wetlands and prepare computerized maps, (2) prepare a hydrological overview of the park, (3) conduct a literature review of research, monitoring, and mitigation actions that cover or impact park lands, (4) review and recommend approaches for the park to interact with present and proposed research, monitoring, and mitigation projects in and adjacent to the park, and (5) review existing baseline data on park water quality, preparing recommendations for additional baseline inventory and monitoring needs for research.

Some of the water quality issues of concern include (1) water quality – groundwater and surface waters, wells, and public water supply systems; (2) erosion and sedimentation problems – involving shorelines, rivers, streams, farming practices, trails, roadway drainages, and urban development; (3) underground storage tanks, septic tanks, and wells, both active and inactive; (4) recreational use and impacts – nature and severity; and (5) determination of actions the park should take under mandates to protect and prevent degredation of park wetlands.

The park faces complex environmental, visitor use, and cultural resource management challenges and we are working to develop an active management program that takes into consideration all the interrelated natural and cultural resources of which we are the stewards.

Rafkind is Natural Resource Specialist at Colonial NHP. He can be reached at FTS 827-8050 or (804) 898-3400.

GRBA was established to illustrate and preserve a portion of the Great Basin physiographic province. GRBA also is charged to provide for continued livestock grazing. Integrating livestock grazing into a preservation management strategy demanded a research study to evaluate the rangeland resources of the South Snake Range, from which a comprehensive range management program will be developed.

In 1988, in cooperation with the Department of Rangeland Resources at Oregon State University, GRBA began a 2-year range resource analysis. This study is also being used to verify, refine, and improve the vegetation classification and mapping effort of the NPS from LANDSAT imagery. Evaluation of rangeland resources includes a survey and description of the present plant communities in the park, analysis of the past status of these communities, and a prediction of future development under various management strategies. Following is a preliminary look at the resource evaluation after the first summer's field season.

Methods

The study area, in the South Snake Range, covers roughly 250,000 acres. Of this, approximately 4,000 acres is private land, 70,000 acres is managed by BLM, 99,000 acres by USFS, and 77,000 acres by NPS.

Reflectance values in four bands from a June 1986 LANDSAT image were used to generate spectrally unique landcover categories for each 30m x 30m area of land (pixel). These landcover categories were the result of an unsupervised classification within the GRASS GIS program. Based on preliminary surveys and observed cover types, a classification by the NPS GIS Division in Denver identified 20 cover types.

From this initial stratification, polygons were identified as potential sampling sites to describe the associated plant communities. A minimum polygon area of 2 ha was the initial criterion established. This was done to minimize the influence of errors either inherent in imagery, induced operationally through data manipulation, or associated with accurately locating uniform areas in the field (Warren et al. 1989). Sampling sites were concentrated on NPS and USFS lands. Within these lands the sites were so distributed that cover types were sampled in each of the major drainages and were proportional to the area occupied by each cover type.

Vegetation descriptions were determined from a 50m x 20m macroplot located within a representative portion of the identified polygon. Each site description included environmental characteristics, species lists and cover, ground cover characteristics, grass and forb production, relative deer and livestock use based on feces occurrences, and tree density, size and age. A total of 104 cores taken from dominant tree species established stand age distribution. Trees were divided into size classes similar to those defined by Blackburn and Tueller (1970) for pinyon and juniper, and by the USFS Ecosystem Classification Handbook (Jensen and Keane, 1987) for conifers and aspen.

Results and Discussion

During the 1989 field season, 50 macroplot sites were visited. Of these, 8 were mountain big sagebrush *(Artemisia tridentata var. vaseyana)* with no tree species present, 15 were various densities of pinyon *(Pinus monophylla)* and juniper *(Juniperus osteosperma)*, 10 were aspen *(Populus tremuloides)*, 6 were other coniferous forest types, and the remainder were meadow and low sage *(Artemisia arbuscula)*.

The pinyon juniper cover type occupies 86,540 acres of the project area. Prior to arrival of European man, pinyon and juniper are believed to have been confined to rock outcrops and other areas protected from fire. There, trees were relatively long-lived, but in low densities. Of the 15 pinyon juniper sites evaluated to date, only one was found to be an old mature stand. This was on a steep, south facing limestone slope. Total tree cover was 19 percent. Cores taken from an old mature pinyon and a juniper were estimated at 400 and 470 years, respectively.

The remaining sites are in areas with less adverse conditions. Of the pinyons aged in these sites, no tree was older than 160 years and most averaged less than 100. Thus, pinyon is a relatively recent arrival. The effect of pinyon on site dynamics can be estimated by comparing site conditions among various densities of pinyon cover in these stands. (Table 1). As the density of trees increases toward a closed canopy condition, the species diversity and the percent cover of shrubs, forbs, and grasses declines. By the time pinyon cover reaches 60 percent, total forb, grass and shrub cover has shrunk from 60 percent to less than 3 percent.

Continued on page 18

Table 1. Mean tree cover, cover and number of species of shrubs, forbs, and grasses, and deer pellet groups per macroplot for several plant cover types at Great Basin NP. (T = trace).

	Percent cover				Number species			deer pellet groups
Cover Type	tree	shrub	forb	grass	shrub	forb	grass	100 m²
Sagebrush	0	33	13	17	6	19	7	69
Pinyon (old stand)	19	18	T	0	3	1	0	0
Sagebrush with scattered pinyon	4	21	9	21	6	20	9	15
Pinyon (young stands)								
Low density	20	23	5	7	6	13	6	48
Moderate density	41	6	2	2	4	10	4	6
High density	60	1	T	1	5	8	5	7
Aspen	81	5	10	3	3	11	4	25
Conifer								
Engelmann spruce	46	2	T	T	1	3	1	1
Limber pine	25	23	7	2	4	1	3	5
Douglas-fir	58	7	T	T	3	3	3	8

Peregrine Falcon Research in the Yukon-Charley Rivers National Preserve, Alaska

By Skip Ambrose and Steve Ulvi

The decline of the peregrine falcon came to symbolize the devastating effects of some man-made chemicals on the environment. Likewise, peregrines have become a showcase of man's ability to protect and recover endangered species. While not all species will be so responsive to human management efforts, the recovery of the peregrine falcon is a genuine success story. Recent issues of ***Park Science*** included several articles on surveys and hacking efforts in parks in the lower 48 states. In Alaska, where peregrines declined to approximately 30 percent of their historical (pre-DDT) levels, there has never been any nest manipulations or hacking. Consequently, peregrine populations in Alaska offer a unique opportunity to study the natural recovery of an endangered species without human intervention. The Yukon-Charley Rivers National Preserve (YUCH) in particular is invaluable for such study because of the historical information available and many years of intensive survey and banding studies.

Three subspecies of peregrine falcons occur in Alaska: the Arctic Peregrine Falcon *(Falco peregrinus tundrius)* inhabits the northern tundra region of the state, the American Peregrine Falcon *(F. p. anatum)* occurs in the forested interior, and the Peale's Peregrine Falcon *(F. p. pealei)* occurs in the coastal regions of the Aleutian Islands, Gulf of Alaska and southeast Alaska. Both the Arctic and American subspecies are highly migratory, wintering as far south as Brazil and Argentina. The Peale's Peregrine Falcon is for the most part a year-round resident within its range, but some movement along the west coast of Canada and the United States occurs. The Arctic subspecies is currently listed as "threatened" and the American subspecies is listed as "endangered." The Peale's subspecies is not considered threatened or endangered.

The decline of peregrine falcons in Alaska may have begun as early as the 1950s following initial use of DDT. Surveys of the past three years recorded numbers over twice those observed in the early surveys, and investigators now believe the very early surveys either missed birds, due to timing of the surveys, or the population was already declining and researchers had no way of knowing this.

Research on peregrines in Alaska has focused on the listed Arctic and American subspecies, and the YUCH has been a principal study area in interior Alaska. As early as 1898, biological surveys in this area documented peregrines nesting on the cliffs that occur along the Yukon River, and in the 1950s, Dr. Tom Cade (1960) surveyed sections of the river. Because of the historical information available, this section of the Yukon River was selected by the Alaska Peregrine Falcon Team as an index population area for monitoring and measuring recovery. Since 1979, intensive surveys, banding and other research have been ongoing in the Preserve. With information dating back to the late 1800s, and continuous intensive research beginning in the late 1970s, few areas offer such an opportunity for research and monitoring.

Surveys in Alaska

Peregrine falcons arrive in interior Alaska about mid-April. Males and females apparently migrate separately but arrive at the nest site within days of each

Great Basin NP Vegetation Management *(Continued from page 17)*

Deer use based on the presence of pellets also declines substantially as the density of pinyon approaches 40 percent.

Examination of size class distributions (Figure 1) within the low (10 to 25% cover), moderate (26 to 50% cover), and high (>50% cover) pinyon density groups

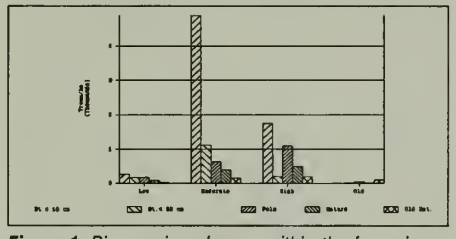


Figure 1. *Pinyon size classes within the four pinyon density classes.*

shows a large number of small plants in the moderate density class. These are the source of future mature trees, which eventually will dominate the sites and outcompete present vegetation. Since the survival rate of pinyons less than 0.5 m tall is relatively high unless killed by fire, this suggests continued increase in density and cover of pinyon on the 37,000 acres of moderate density pinyon sites. Any increase in pinyon can be expected to be accompanied by further loss of diversity and cover of associated forbs and grasses. The area most heavily used by deer would be further reduced.

The aspen cover type occupies 10,150 acres. Aspen are frequently a temporary, dominant, seral species in a variety of climax conifer associations following severe disturbance such as fire (Mueggler and Campbell 1986). Examination of the size class distributions (Figure 2) shows a large number of saplings (<1.5 m tall), pole (<12.5 cm dbh and >1.5 m tall), and mature (12.5 to 35 cm dbh) trees but no large mature trees (>35 cm dbh). Average age of trees in the pole size class was 74 years and in the mature size class, 107 years. Seedling and sapling white fir *(Abies concolor)*, and limber pine *(Pinus flexilis)* are found in these stands. These small conifers averaged 50 years old. The presence of small conifers in the aspen communities suggests that aspen in most of this area is a seral species having become established 90 to 120 years ago following a disturbance of some sort. Fire scars on standing trees and charcoal found on these sites indicate fire occurrences. Fire suppression has been shown to contribute to a reduction of regeneration in aspen communities. Thus, under present management policies, these stands are expected to become dominated by conifers with a loss of aspen.

Conifer communities occupy 25,880 acres. They appear to be long-lived communities. Recruitment in the limber pine stands appears to be small, but survivability is high, so there are a number of large specimens (Figure 3). Douglas-fir *(Pseudotsuga menziesii)* and Engelmann spruce *(Picea engelmannii)* appear to have a greater rate of establishment but a lower survival percentage, resulting in a similar number of large trees compared to limber pine. Maximum ages of the large trees were at least 381, 372, and 237 years for the Engelmann spruce, limber pine, and Douglas-fir, respectively. (Larger trees were present but equipment limitations prevented sampling of trees larger than 60 cm dbh). It appears these communities have changed relatively little since arrival of European man. With no disturbance, these stands probably will change little in the future except for an increased build-up of dead and down wood.

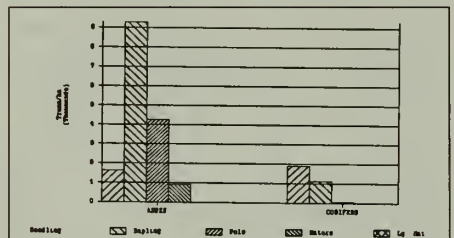


Figure 2. *Size class distribution of aspen and conifers in the aspen cover type.*

Summary

Examination of the rangeland management program at GRBA has developed awareness that livestock management alone will not overcome the major vegetational changes occurring in the park. These changes were set in motion by humans decades ago, through overgrazing and the fuel reduction it causes. People continue to affect the dynamics of plant communities through suppression of naturally occurring fires. Fire management at GRVA is currently being reviewed. Refinement of this program is dependent on understanding today's plant communities and the historic role of fire.

Preliminary evaluation of GRBA's plant communities suggests that alternative management options will become drastically diminished if present successional trends continue. Associated with the on-going change is a reducation of vegetation diversity and a corresponding decrease in wildlife abundance.

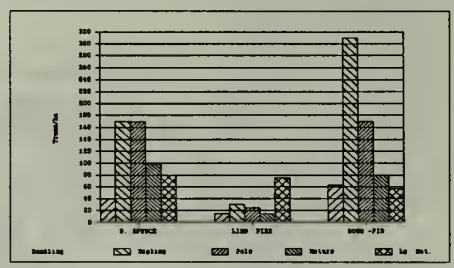


Figure 3. *Size class distribution of the dominant conifer in the Engelmann spruce, limber pine, and Douglas-fir cover types.*

Jaindl and Eddleman are Research Associate and Associate Professor at OSU; Brock and Byelich are the Resource Management Specialist and Range Technician at GRBA.

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***Adult female** feeds her young. Notice the FWS band and black aluminum band with alpha-numeric code.*

other. Breeding activity is initiated immediately, and the first eggs are laid by early May. Our first surveys, to determine nest territory occupancy and the number of pairs attempting to breed, begin about two weeks after the river ice breaks up – usually between May 5 and May 15. Large ice floes, trees and debris congest the river and make travel dangerous for about two weeks after breakup, so surveys generally start about May 25. Eggs hatch between early and mid-June, and we plan our second survey to correspond with the optimum banding age, about three weeks. Our second surveys generally occur during the first two weeks of July.

A 20-foot river boat with a 90 horsepower outboard is used to survey the 165 mile stretch of the Yukon River between the Alaska-Yukon Territory border and Circle, Alaska. Inflatable rafts, flown to the headwaters in helicopters or small fixed-wing aircraft, are used to survey the tributary rivers. Ground surveys, as opposed to aircraft surveys, are essential for accurate results.

Other research projects concerning peregrine falcons or their prey also have been conducted during the past 10 years. Trapping adult falcons to determine dispersal, movement and mortality was initiated in 1981. Beginning in 1986, all young and adults trapped were banded with alpha-numeric coded color leg bands in addition to the standard USFWS leg band. Using high-powered spotting scopes, we are able to identify individual falcons in subsequent years without the need to trap and handle the birds. Pesticide studies on peregrine eggs were conducted in 1984 and again in 1989. Prey remains are collected from occupied eyries every year for identification, and in 1985 and 1986 a study on prey selection was conducted. A limited home range study using radio-telemetry was undertaken in 1986.

The wide variety of survey techniques employed in the past, and the resulting difficulty in analyzing survey data, led the USFWS and others to develop standardized techniques for surveys and data collection in Alaska. These require at least two trips through study areas, one during incubation and another when the young are three to four weeks old. At least four hours of observation at any known or suspected nest site is necessary before a determination of the status of that site can be made. Finally, all survey data are recorded on a Raptor Observation Record Card developed by the USFWS for raptor surveys. A computerized database was developed in conjunction with the card facilities data entry and analysis. This card and database was further refined in cooperation with NPS scientists in other regions and is now used in several other states.

Results of Falcon Research in the Preserve

The earliest surveys along the Yukon River in the Preserve area documented 15 to 16 pairs per year (Bishop 1900, Cade 1960). In 1966, 15 pairs and 27 young were observed (Cade et al. 1968). The lowest recorded level was in 1973 when Ritchie (1976) observed 11 pairs, 1 single adult and 16 young. The population remained near this level until 1978 when the first increases were detected. That year, 16 pairs, 3 single adults and 28 young were seen. The population has continued to increase through 1989 when 33 pairs, 2 single adults and 54 young were seen (Ambrose et al. 1988). Surveys along the major tributaries such as the Charley, Kandik, Nation and Tatonduk rivers documented similar increases. In recent years, it has not been unusual to find 50 or more occupied sites and 80 to 100 young. A crude estimate of the total population in the preserve is 60 to 70 pairs, and possibly more in the highest years.

Cade (1960) estimated the interior Alaska peregrine population at 250 pairs. Recent surveys throughout the interior suggest that pre-DDT population number may have been higher than Cade's figure. The increases of the peregrine population during the past 10 years have been truly remarkable.

With a sizeable and healthy population, we were able to undertake research projects that were fundamental to understanding the biology of peregrine falcons. Some of these projects were not

Continued on page 20

The Yukon-Charley Rivers National Preserve

The Yukon-Charley Rivers National Preserve was established, in part, to ensure the protection of habitat for and populations of all fish and wildlife including the endangered American Peregrine Falcon.

This stretch of the Yukon River offers abundant cliffs and highly diverse lowland topography and vegetation within relatively short distances of nesting territories. The Yukon River valley is composed of low, rounded benches and ridges trending southwest to northeast and averages 2-3 miles in width.

The preserve lies within a climatic division of Alaska known as the interior basin. The mountains to the north and south tend to block the moderating influences of oceanic air masses, resulting in extremely low temperatures in the lengthy winter and high temperatures and low precipitation during the summers.

The complex geologic structure, severe semi-arid continental climate, frequent occurrence of wildfire, and discontinuous permafrost soils have interacted over time to create a complex mosaic of taiga and upland tundra biotic communities. The present diversity of subarctic flora and fauna reflect this interplay of physical processes and the near absence of late Pleistocene glaciation.

These vegetative communities experience annual natural perturbations such as ice-scouring, flooding, frequent wildfire, and insect infestations that result in a dynamic vegetative mosaic. In turn these diverse and productive seral stages provide excellent habitat for birds returning to breed in the summer. Only two dozen birds are considered resident in this area but with the onset of the intense subarctic spring nearly 160 species (including 17 raptors) are known to breed here.

For many raptor-watchers and biologists raised in the post-World War II era of widespread pesticide use and its dire consequences, the opportunity to observe healthy populations of American Peregrine Falcons in a wildland setting is only a dream. Rugged bluffs and layered outcrops tower above turbid waters along the heavily forested Yukon River corridor. This is a time-worn landscape that is by any measure outstanding peregrine habitat. The vast proportions of the country carved by "The Great River" stretch the human imagination and seem a perfect backdrop for the whistling of sickle-wings in determined stoops.

Army Chopper Rescues Falcon Counters

Five volunteer peregrine falcon counters, who had been manning sites on both sides of the Port Mansfield Channel (about 60 miles north of the Padre Island National Seashore), had to be airlifted out of their soggy sites in early June when the rains set in before their spring survey was completed.

The group, all of whom are experts in handling birds of prey, tried to continue their survey throughout the storms, but the attempt proved futile. They were sinking into the saturated sands and their equipment was too heavy to move under such conditions. The Corpus Christi Army Depot chopper had to make four trips to get the surveyers and their gear to high, dry land.

The survey effort is funded by the U.S. Army and collects information on the peregrine falcons migrating through this area. In spring, the birds are returning from either Latin America or Mexico, enroute to Alaska, Canada or Greenland. This year the group encountered 125 birds, which is about average.

The program is "permitted" through the USFWS, the NPS, and the University of Texas. It began in 1978. This year's team was headed by Tom Maetchle, who is working on a Doctorate at Boise State. "In the fall," he said, "we might find as many as 400 falcons migrating through here. The birds are younger, less experienced – 60 to 70 percent of them won't live through their first year." The average life span averages 10 years – if the birds make it through their first year.

The team covers an area 40 miles long by 12 miles wide. The birds are banded, blood sampled, measured, and released. Surveyors have found that birds who migrate from the farthest north, travel the farthest south. They also have found that the levels of pesticides have been decreasing in certain parts of the world.



***Volunteer Scott Francis** rests on his ATV in between trips to drier land. The air support saved the falcon team days of work in moving their equipment via ATVs through miles of sopping sand. (U.S. Army Photo by Francoise Cymes).*

Peregrine Research *(Continued)*

feasible, biologically or politically, in any other area of the United States. Over 1500 nestlings have been banded in interior Alaska since 1979, many of these in the Yukon-Charley Rivers National Preserve. Close to 100 recoveries outside Alaska have revealed major migration routes, staging areas and wintering areas. Given the changing nature of habitats all over the world and the continued use of harmful pollutants in many areas, this information is critical to management of the species.

In addition to recoveries outside Alaska, nearly 200 recoveries in the state have resulted from our adult trapping effort. This trapping has allowed us to determine dispersal patterns from natal areas, age of first breeding, turnover of adults at nest sites, movement of breeding adults between nest territories, and adult mortality. Age of first breeding appears to be related to density of the population and available nest sites; females tend to disperse farther than males (mean of 75 miles for female versus 43 miles for males) (Ambrose and Riddle 1988). More importantly, with this understanding of age of first breeding (in both a depressed and recovered population), breeding success of different aged birds, and normal dispersal distances, we can lend insight into recovery potential and timing in other areas.

Future Management Considerations

The peregrine population in the Preserve appears to be nearing full recovery. Peregrines in Alaska will likely be considered for delisting in the next few years. Continuing pesticide use and habitat changes along migration routes and in wintering areas, and their unknown cumulative effects, make future monitoring critical. Expansion of research and inventory and monitoring efforts on this unique population will provide the opportunity to assess and monitor several aspects of the biodiversity of these river ecosystems. Such research should allow us to measure to some degree the effects of pollutants and habitat alteration outside the United States. The peregrine is an effective ecological generalist and as such is an excellent indicator species, reflecting subtle changes in the environment.

Ambrose is Project Leader for the Endangered Species office of the USFWS in Fairbanks, Alaska, and the Recovery Team Leader of the Peregrine Falcon Recovery Team, Alaska Population. Ulvi is Resource Management Specialist for the Yukon-Charley Rivers National Preserve.

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ROMO Raptor Survey

All Park areas in the Rocky Mountain Region known to have peregrine falcons are in the midst of raptor surveys. One goal is to survey all of the suitable habitat for peregrine falcons by fall, 1991. NPS is co-operating with USFWS in a peregrine prey contamination study designed to follow-up a similar study completed 10 years earlier. The results should give insight into the peregrines' recent population increase and may provide clues as to why certain segments of the population continue to experience poor reproductive success. The NPS has co-operated with USFWS in a color-banding protocol for the western U.S., consistent with the protocol for Alaska, Canada, and Greenland. The bands, easy to read from a distance, will provide more information with less handling of the birds.

Monitoring Case Studies Selected

By Gary E. Davis

Tom Wilson's cartoon character Ziggy found the park "CLOSED FOR INVENTORY" in his cartoon that ran on Sunday, July 8, 1990. Wilson's art does more than imitate life, it foreshadows it. With existing operating funds, the NPS is faced with a Hobson's choice of closing the parks to inventory and monitor them or literally running them into the ground.

How much is needed to inventory and monitor natural resources? Pro-rating from prototype programs like Channel Islands and Shenandoah NPs to account for smaller and larger parks, it appears that the NPS needs about $200 million a year. Is it worth the investment? How can we find out? Funding a few model programs and gaining firsthand experience is probably the best way, but it will take 10-15 years to reap the real benefits. A much quicker, but less certain, way is to examine case histories of long-term studies that simulate monitoring.

Heeding the adage that those who do not learn from their history are doomed to repeat it, the NPS Inventory & Monitoring Steering Committee commissioned a series of case studies to evaluate cost estimates and to develop confidence in the value of monitoring programs. A group of 19 superintendents and scientists met at Channel Islands NP July 24-27, 1990 and selected 15 examples of major natural resource issues involving monitoring or long-term research. Case studies of the selected issues will be used to determine the relative values and costs of resource monitoring and long-term research for park management.

The Regional Chief Scientists and about 50 senior managers and field scientists nominated nearly 100 candidate cases last spring. We organized those into issue categories identified in the 1987 GAO report on "Threats to the Nation's Parks" to structure the workshop and help assure a representative sample of issues in the final selection. Each workshop participant introduced the nominated cases in one category and moderated the ensuing discussion. After nearly two days of presentations and discussion, the group agreed on 36 cases, all of which addressed major issues, used or needed long-term data sets, and had reached a conclusion. The 15 best cases also showed some universality in setting precedents for other areas, represented programmatic rather than ad hoc approaches to monitoring, and demonstrated an NPS management commitment to continued monitoring.

Case Studies Selected to Evaluate Monitoring Programs

ISSUE: THREAT TO ECOSYSTEM INTEGRITY – AESTHETIC DEGRADATION
- Adjacent Community Growth & Development – SAGU Fire Research & Management – YOSE & SEKI
- Predator/Prey Relationships and Ungulate Herbivory – ISRO
- Saguaro Cactus Dynamics – SAGU

ISSUE: ALTERATION OF WATER QUALITY OR QUANTITY
- Devil's Hole Pupfish/Water Rights – DEVA
- Water Diversion – EVER
- Water Quality – MACA

ISSUE: CONSUMPTION OF RESOURCES
- Native Fish Exploitation (Cutthroat Trout) – YELL
- Fisheries Management – EVER

ISSUE: IMPACT OF ALIEN SPECIES
- Biological Invasions – HALE & HAVO
- Goat Management – OLYM

ISSUE: PHYSICAL IMPACTS OF VISITORS
- Wilderness Research & Management – YOSE & SEKI

ISSUE: AIR POLLUTION
- WHITEX/Navajo Power Plant – GRCA

ISSUE: PARK OPERATIONS
- Rare Plant Management – INDU
- River Use Management – OZAR

DEVA = Death Valley NM; SAGU = Saguaro NM; YOSE = Yosemite NP; SEKI = Sequoia/Kings Canyon NPs; ISRO = Isle Royale NP; EVER = Everglades NP; MACA = Mammoth Cave NP; YELL = Yellowstone NP; HALE = Haleakala NP; HAVO = Hawaii Volcanoes NP; OLYM = Olympic NP; GRCA = Grand Canyon NP; INDU = Indiana Dunes NP; and OZAR = Ozark NP

The July-August issue of *BioScience* is devoted to discussions of long-term ecological research.

The final list contains examples of all 7 major categories of resource issues from 15 parks in 5 regions. The product of the workshop is a document that defines the 15 best cases and describes the contents of each case study. The studies are scheduled to be conducted in FY91 by nationally recognized experts on the issues. Each study will present a history of the case, describe the monitoring program (or long-term research), define the issues addressed, and describe the role of monitoring in determining how issues were perceived, approached, resolved, and evaluated. The relative costs and values of long-term monitoring (or research) will be analyzed and presented at the conclusion of each case study. The case studies will be presented at a national symposium, and compiled, analyzed, and published.

A valuable byproduct of the workshop was the camaraderie and communication that developed among a diverse group of park managers and scientists as they struggled together with a common challenge. The group represented 10 parks, 7 regional offices, and 2 Washington office divisions, and came from many different professional backgrounds. The workshop was conceived and conducted by research scientists Gary E. Davis and William L. Halvorson and superintendent C. Mack Shaver, Channel Islands NP. Participants were Jim Carrico (Big Bend NP), Jay Goldsmith (Western Region), Ron Hiebert (Midwest Region), Gary Johnston (WASO Vegetation & Wildlife), Randy Jones (Olympic NP), Lloyd Loope (Haleakala NP), Cliff Martinka (Glacier NP), Dave Mihalic (Mammoth Cave NP), Bill Paleck (Saguaro NM), Stan Ponce (WASO Water Resources), Mike Soukup (Everglades NP), Brian Underwood (Mid & North Atlantic Regions), John Varley (Yellowstone NP), Jan VanWagtendonk (Yosemite), Richard Whitman (Indiana Dunes NL). Ro Wauer, retired NPS, was an active observer from the National Academy of Sciences panel reviewing NPS science programs.

A Pertinent Letter from Alaska?

The word "inventory" is a downer. To inventory furniture and equipment against property lists is biologically sterile and intellectually boring unless something expensive turns up missing – resulting in sheer terror (another negative).

The sign in the store window, "Closed for Inventory," means tediously counting stock down to the last nut and bolt, usually so it can be taxed (also an unpleasantry).

Once, NPS tried Resource Basic Inventory (RBI), in an attempt to find out everything about everything in a park. That made even the strongest scientists blanch and it curled the upper lips of superintendents and rangers. I know. I was there!

Monitoring, however, is the life blood of an agency. We monitor animal populations, wildland fires, bear/human interactions, livestock grazing, weather conditions, visitor statistics, sewage treatments, pesticide uses, law violations, salaries and leave times, ad infinitum. Data gathering is necessary for monitoring, but when was the last time you heard it called "inventory"? Of 183 Areas of Expertise listed in the NPS Natural Resources Personnel Directory (printed in 1988), only once – in "Baseline Inventory and Monitoring," was the word "inventory" included.

Management, on the other hand, was mentioned 37 times, which shows where the money is. And of 624 people in the directory, only 14 mentioned inventorying as one of their specialties.

The problem remains: We badly need Inventory and Monitoring and we aren't getting it. Blaming part of the problem on a word may seem simplistic, but I'm not sure it is. The primary reason I&M has not worked, in my opinion, is that it is aimed at the future, while we want – or have – to focus on today's problems and needs. The recent revival of interest in I&M (NPS-75) is an attempt to break away from the work-a-day world to gather data about baselines and changes – needed for future decisions.

Is that important? How else can we determine what we have, and manage to leave it unimpaired for generations to come, while at the same time providing for its enjoyment?

But I repeat, the name doesn't help. "Inventory," with its suggestion of trying to find out *everything*, is discouraging. Do I have an alternative? Does Alaska have snow and ice?

My solution is: Just call it "natural resource monitoring." Natural Resource Monitoring should be a full partner with Natural Resource Research and Natural Resource Management. It would be the repositor and collator for the wealth of information obtained by Research and Management, would ask those functions to gather whenever possible data not needed for immediate problem solving (against future needs), and be staffed and equipped to get additional data.

What's in a name? Lots! For example, NPS employees rarely talk about "working for a government bureau," or call themselves "bureaucrats." What chance would an Edsel have today, even without the toilet seat, in a world full of Cougars, Cavaliers, Corsicas, Conquests, or even my own little Dodge Colt (which is really a Mitsubishi)? How about the Peacekeeper Missiles and Freedom Fighters of the last Administration? We really *need* Inventory and Monitoring, so let's drop the negative word, accentuate the positive one, and get on with the job.

Al Lovaas
Chief Scientist, NPS Alaska Region

Arctic Steppe: Snapshot of the Past or Glimpse of the Future?

By Sara Wesser and Penny Knuckles

When continental ice sheets blanketed much of North America, land was exposed connecting Siberia and Alaska, forming an area known as Beringia. Paradoxically, Beringia itself remained unglaciated and may have been covered with vast areas of steppe, a vegetation type characterized by grasses and low shrubs very different from the present widespread forest and tundra of the region. Today, a few geographically isolated plant communities of this type survive only in Siberia and Yukon-Charley Rivers National Preserve in Alaska. High above the waters of the Yukon River, arctic steppe communities contrasting distinctly with the surrounding taiga forest find refuge on a few steep, south-facing river bluffs near the border between Alaska and Canada.

A chain of ecological islands strung along the Yukon, the steep bluffs above the river preserve these unique assemblages of plants. Endemic species found on one bluff are not always present on the next a few miles away, but other species are common to all. Four taxa are candidates for federal listing as endangered species, while the population levels and distribution of several others is too poorly known to justify classification at this time. Disjunct populations of mosses and lichens also occur, their nearest relatives 2,000 miles away in Siberia.

This persistence of a plant community prevalent during the Pleistocene on today's dry south-facing slopes is puzzling. What conditions have allowed the survival of arctic steppe and what conditions limit its present distribution? There is evidence that today's steppe species are at the limit of their ecological and distributional ranges. Warm, treeless islands in a sea of cool, mesic forest, arctic steppe intergrades with the aspen and tundra. What factors control this interface? More importantly, how do fluctuations in climate affect the distribution of steppe species? These questions prompted the research that we describe.

The mere logistics of studying these steep, south-facing bluffs challenged both researcher and park manager. Hot daily climbs lugging water and equipment up unstable scree were never merely routine, since bears frequent the same slopes. Mini-landslides could send the objects of study tumbling downhill. Eroded trails appeared like magic. American peregrine falcons, an endangered species, and other raptors oversaw projects from their nest sites. Over-zealous collectors, while not yet a problem, could have decimated rare plant species. Logistics were complex, since the study site required boats for access during high water.

Despite these factors, Eagle Bluff was chosen as a study site. Twelve miles upriver outside the preserve boundary, it is representative of arctic steppe on other bluffs within the preserve. While the site's location adjacent to the town of Eagle had its advantages, it was still necessary to cross a large creek via hip waders or an exciting cable ride. The peregrines nesting on the opposite side of the bluff are somewhat habituated to human use. Fortunately, a trail to the study site already existed.

I, Sara Wesser, as principal investigator, recall feeling a bit daunted by my first view of Eagle Bluff in 1987 as I rounded a bend in the Taylor Highway. I remember slowing my vehicle to a halt as my eyes traversed the 2000 foot rise from the Yukon River to the top. After an initial feeling of dismay – surely the bluff supporting the arctic steppe community was not quite so steep nor so high! – those doubts were put aside by the thought that I was at Eagle Bluff precisely because that imposing slope provided the perfect environment for an arctic steppe community. The next two field seasons focused on analyzing the environmental conditions of the bluffs that allow the steppe communities to survive.



Eagle Bluff Study Site *(Eagle is in background) Shade treatment in foreground.*

The goal was to describe the abiotic and biotic factors that control species distribution across the transition betweeen steppe and forest. These questions were addressed using correlative methods to show relationships between vegetation and environment and experimentation to test predictions from correlative models and establish the causal pathways of species' response to environment.

A correlative model was developed to portray explicit hypotheses about vegetation-environment relationships. To do this environmental variables were measured and percent cover of all understory species present was sampled in 70 plots. Environmental variables included the extent of tree cover (an estimator of radiation below the canopy), litter, slope, aspect, soil temperature and moisture, pH, organic matter and disturbance. Among the measured variables, soil moisture and the extent of tree cover most strongly controlled the transition in species composition. It was assumed that understory species responded most strongly to the influence exerted by tree cover on radiation below the canopy. Soil moisture controlled the tree cover itself.

If species are distributed according to their physiological optima (that is, where their growth would be best in the absence of biological factors such as competition or herbivory which may reduce physiologically potential growth and survival), we would expect each species to be most robust in the light and moisture environment most similar to its native habitat. Forest species would perform best in the low light and high soil moisture characteristics of forests, and steppe species in the high light and low soil moisture of steppe. However, species are not always distributed this way. Biotic factors (e.g., competition for limiting resources) eliminate species from sites that are otherwise more favorable for their growth. An alternative explanation of the results of the correlative model that was developed: steppe species may tolerate aridity better than forest species but are excluded from the more mesic and presumably more favorable conditions inhabited by forests today due to low light conditions.

These hypotheses were tested in experiments with two forest natives and two steppe natives transplanted into the steppe community. To test for the effects of light, plants were either shaded to simulate the low light levels of the forest, or left unshaded in the steppe's high light environment. To test for the effects of soil moisture, plants were either watered daily to simulate moist forest soil conditions or were given no supplemental water in the dry steppe. The results suggested steppe species are eliminated from forest areas primarily by competition for light, but revealed differences in the relative importance of environmental factors among species. The forest taxa appeared to be restricted to their observed range because of intolerance for the high light and dry soil of steppe. Growth of steppe taxa would be improved in the mesic conditions of forest if they were not limited by the forest's low light.

If arctic steppe provides a snapshot of environmental conditions 12,000 years ago, can changes in its distribution indicate global climate trends in the future? Since steppe communities span two ecotones (steppe-forest and steppe-tundra), minute variations in climate could cause observable changes in the vegetation of steep south-facing bluffs. The distribution of

Effects of Global Warming on Freshwater Ecosystems

By Jerome E. Freilich and G. Wayne Minshall

The idea of global climate change is mostly speculation at this point – a prediction founded on some still fairly shaky evidence. Yet it would be unconscionable not to give the possibility serious consideration. We offer these thoughts on global warming and its effect on freshwater ecosystems while at the same time wishing to avoid proposing dire consequences based on too little data, putting too much faith in preliminary scenarios or failing to consider other plausible alternatives. Our comments are based on a symposium, "Troubled Waters of the Greenhouse Earth: Climate Change, Water Resources and Freshwater Ecosystems," held at Virginia Tech in May 1990, the results of which will be published by fall of 1991.

Estimates predicting a doubling of atmospheric CO_2 levels within the next 100-150 years are today almost universally accepted (Schneider 1989). If this occurs, global average temperatures may increase up to 5.5°C. and precipitation will increase by 7-11 percent. In general, the central parts of the continents will get warmer and drier in summer. The oceans will warm more slowly than the continents, while the polar regions will warm more than the equator. The largest temperature changes will occur in the fall and winter seasons at the high latitudes of both hemispheres.

An initial response to warming will be increased levels of methane derived from bacterial metabolism in tundra and boreal wetland ecosystems during summer months. The huge expanse of Canadian and Siberian tundra will provide large amounts of this greenhouse gas to the atmosphere, compounding the greenhouse effect. As warming proceeds, melting will lower the permafrost layer, further increasing the release of methane. This effect is fairly easy to project because arctic ecosystems are relatively simple. In temperate and tropical areas, effects will be no less significant, just harder to estimate.

All global processes are linked, so terrestrial events will have effects on streams. Streams will then reflect these effects in their transport of materials to the oceans. The River Continuum Concept (Vannote et al. 1980), a basic component of present stream ecology, views rivers as more than simply downstream transporters. Important nutrient materials moving downstream are retained by physical (e.g. leaves in a log jam) or biological means (e.g., aquatic insects) and held in place where they may be further processed or "spiralled." Under the effects of global warming, input and retention of vital materials in streams will be significantly altered. For example, warmer temperatures will increase rates of bacterial respiration in soil, leading to increased consumption of soil organic material. This, in turn, leaves less material to be leached into streams, and hence lower levels of dissolved organic carbon (DOC) available to stream organisms.

Streamwater nitrogen concentrations are tightly linked to microbial transformations in soils, so alterations of temperature probably will affect the amount of nitrate entering streams. Concentrations of phosphorus are also tightly bound and closely regulated in stream ecosystems. Changes in streamflow will have pronounced effect on the net retention of phosphorus by streams and their transport of this vital nutrient to coastal estuaries.

In many parts of the world, leaf litter input is the chief energy source driving stream ecosystems. Invertebrates shred the leaf material and make the resulting fine particulate organic matter available to the rest of the food chain downstream. Changes in terrestrial vegetation are inevitable in most global warming scenarios. Whether by changing growth patterns or community species composition, these alterations will have an effect on stream ecosystems. As trees die, streams will initially receive an increased loading of woody debris. Primary production of algae might increase due to holes in the canopy shading the stream. Thereafter, nutrient inputs to streams will change as the composition, condition, and timing of leaf litter input changes.

Although stream animals are noted for their resistance to frequent disturbances (like flooding), changes on a larger or more frequent scale, will not necessarily fall within the animals' ability to adapt. Individual animals will have to cope with change over unprecedentedly short times. Life cycles of aquatic insects are strongly affected by temperature cues. Populations of lotic species (those that occur in flowing water) in non-optimal thermal habitats are characterized by low population density and small-bodied individuals. Animals faced with sudden exposure to unusual conditions will have only three choices: to move, adapt, or die. Considerations of genetic makeup and phenotypic variation suggest that *in situ* adaptation is more likely than shifts in geographic range. Extinction of some species remains a possibility.

Some predictions say that global warming will favor increased rates of forest disturbance due to forest fires, convective wind storms, coastal flooding, and hurricanes. Alterations in flow can affect storage and transport of DOC, nitrogen, and phosphorus. Present projections conclude that if floodplains are drier and there is less anaerobic activity, there will be a subsequent decrease in denitrification causing an increased pulse of inorganic nitrogen reaching streams. Whether this increase (and a related phosphorus pulse) will continue, or whether the situation will result in rapid soil depletion with dire effect on streamlife, is still not clear. Flow regime and vegetation of the flood plain will also have a strong influence on the amount and type of sediment washed into streams. Siltation directly influences habitat available to stream insects and the eggs and fry of fish.

There have been 10 major and more than three dozen minor periods of glaciation in the last million years. Yet scientists at the Climatic Research Unit in England reported that 1988 was the hottest year since records have been kept. They further reported that the six hottest years of the century all occurred in the 1980s. Without additional paleoecological research, little additional help will be derived from the past on what might occur in future aquatic environments. Human activities already have stressed natural systems so severely that it becomes difficult to separate these disturbances by discrete causes. An adequate supply of high quality fresh water is essential to our society. We need to be able to predict the effect of different climate change scenarios to protect what we have, to maintain productivity and diversity, and to develop acceptable alternatives for management.

Freilich recently completed a doctorate in aquatic entomology at U/GA; his research focused on behavior of stoneflies at Grand Teton NP.

Minshall, professor of biology at ID/St/U, is a well-known stream ecologist, and was final summation speaker at the Troubled Waters conference mentioned in this article.

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Arctic Steppe *(Continued)*

steppe communities may depend on conditions that ensure a high light environment by eliminating the growth of trees, a circumstance likely to occur if conditions become drier. Steppe species might thrive under these conditions because of their aridity tolerance. On the other hand, if conditions become more moist we might expect the distribution of trees to expand, favoring forest understory species. Steppe species might then lose the competitive battle for light as forest encroaches onto south-facing bluffs.

These questions suggest that long-term monitoring of arctic steppe communities, supplemented by basic research, may show them to be useful barometers of global climate change. As interest in that international issue grows, arctic steppe provides a tangible link to our Soviet neighbors and glacial past, a link that may someday result in designation of the Yukon River bluffs as part of an international park.

Wesser is a Biologist at the NPS Alaska Regional Office; Knuckles is a Natural Resource Management Specialist at Yukon-Charley Rivers National Preserve.

In the Next Issue

Because of the additional work involved in preparation of the Global Change insert, the deadline for ***Park Science*** *copy was earlier than usual. Many Regional Highlights, the MAB column, and A Sociological Study of Everglades Backcountry by William Stewart, Ray Snow and Mark Ivy will all appear in the Winter issue.*

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PARK SCIENCE

NATIONAL PARK SERVICE

SUMMER 1990

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management

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Cover: *An electron micrograph shows a dry sandstone crust interlaced with cyanobacteria, enlarged 90 times. (Story pages 3,4).*

Guest Editorial

By Eugene Hester, *Associate Director, Natural Resources*

These are exciting times in Natural Resources in NPS. We have nearly completed the groundwork for future improvements, including completion of the Natural Resources Assessment and Action program, development of new guidelines for planning and implementing resource management activities, and training nearly 100 graduates of the Natural Resource Management Trainee program.

Among several exciting initiatives getting underway is our advocacy of parks as appropriate places for global change studies and our expectation that our role in this program will begin in FY 91. *(See page 10.)*

Understanding our natural resources and what is happening to them over time (Inventory and Monitoring) is one of our most basic needs. Last year I convened a task force to expedite implementing I&M strategies outlined by the "Evison Committee." Based on the task force results, I allocated FY 90 funds to start implementing the program and developed proposals for FY 92 and a 10-year plan. We have great potential to improve our research and resource management programs, but need a clearer understanding of our needs and a plan to meet those needs. I am recruiting a deputy associate director to give the kind of day- to-day oversight I believe these initiatives need. Also, I have recommended a number of other FY 92 resource management funding proposals.

Congress asked us to do a study of our research program and make recommendations for its future. The National Academy of Sciences has that study underway with an excellent panel that includes members with experience in NPS and government research administration. It should be able to provide genuinely helpful recommendations. Finally, we have a director who is a real advocate for developing and using scientific data bases.

Other activities that attest to our bright future are the recent Regional Chief Scientists' meeting and a meeting of Natural Resource Specialists at a training workshop in Denver in May. While the RCSs have been meeting regularly, this was the first meeting of NRM personnel. It was organized by regional personnel (special kudos to Kathy Jope), based on their perceptions of the need to have a stronger natural resource management focus throughout the organization. Among the themes that emerged was that research often developed excellent management recommendations, but there often is no funding or personnel to implement them.

Funding is not the only deficit; we still have need for more well-trained specialists, as well as generalist rangers with good education in natural resources. Another theme was the need for more strategic planning and objective setting. Finally, improved communication and cooperation emerged as a prescription for improved natural resource management.

I expect to move forward, making more effective use of our existing resources and proving, with the expected FY 91 increases, that we can make wise use of additional resources. Less case-by-case crisis management and a more programmatic approach is needed, as well as consideration of the larger ecosystems and biogeographical areas in which our resources are embedded.

To effect these improvements, we must provide increasingly effective national and regional leadership and strategic planning, and we must move forward with park-based information and with adequate resources directed at the park level.

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Microbiotic Crusts: Their Role In Past and Present Ecosystems

By Jayne Belnap

Microbiotic crusts are found throughout the world, from the hottest deserts to polar regions. Most of these crusts are dominated by cyanobacteria, and also include lichens, mosses, green algae, microfungi, and bacteria. The crusts are critical components of these ecosystems, significantly modifying the surfaces on which they occur. In the cold deserts of the Colorado Plateau region (parts of Utah, Arizona, Colorado, and New Mexico), these crusts are extraordinarily well-developed, and may represent 70-80 percent of the living ground cover.

Cyanobacteria, previously called blue-green algae, are the oldest form of life known. The earliest fossils found, called stromatolites and dating back more than 3.5 billion years, are extremely thick mats of these prokaryotic organisms. It has been suggested that it was these marine organisms that converted the earth's original carbon dioxide-rich atmosphere into the oxygen-rich atmosphere necessary for the evolution of life as we know it today. Stromatolites are still being formed along the coasts of Baja California, Africa, and Australia, where meters-thick mats of cyanobacteria such as *Microcoleus chthonoplastes* and *Lyngbya* can be found in various stages of fossilization.

Cyanobacteria occur as single cells or as filaments. The most common form found in desert soils is the filamentous type. The cells, or filaments, are surrounded by a sticky mucilaginous sheath that is made of polysaccharides and other compounds that can be extremely persistent in these soils.

Their Soil Binding Role

One ubiquitous species, *Microcoleus vaginatus*, not only has sheaths around each filament, but has filaments occurring in bundles that are surrounded by a common sheath. When moistened, these cyanobacteria become active, moving through the soil and leaving a trail of sticky mucilage behind. The sheath material sticks to surfaces such as rock or soil particles with which it comes into contact. Since many of these cyanobacteria occur in long filaments, the result is an intricate webbing of fibers throughout the soil, joining soil particle to soil particle, like beads on a string.

As with fiberglass, this webbing gives the soil great stability and tensile strength, and enhances resistance to erosional forces such as wind and water. Of considerable significance is the fact that this binding action is not dependent on the presence of living filaments: layers of abandoned sheaths, built up over long periods of time, can still be found clinging tenaciously to soil particles at depths greater than 15 cm in sandy soils. These sheaths provide cohesion and stability, even at depth, to otherwise highly erodable soils.

The sheaths have other functions as well. They are extremely hydrophilic, swelling up to as much as 10 times their dry size when moistened. Consequently, the sheaths become a way of intercepting and storing water, especially important in arid areas where rainfall is sporadic and intense. This enables the cyanobacteria, which are active only when wet, to remain active longer.

Their Nutrient Holding Role

Recent research also shows that vascular plants grown in crusted areas have much higher levels of essential nutrients than plants grown in areas without crusts. Electron micrographs of *Microcoleus* suggest a mechanism for this nutrient enriching property. Pictures show the outer sheath of cyanobacteria covered with fine clay particles. Both the sheaths themselves and the adhering clay particles are negatively charged; therefore, they attract and bind important positively-charged nutrients, keeping them from being leached out of the upper soil horizons or becoming bound in a form unavailable to plants.



Microcoleus vaginatus *is a major constituent of soil crusts on the Colorado plateau. This 700 times enlargement shows the filaments clustered in their common sheath, like a bundle of optical fibers. When moistened, they move through soil and weave it together with their sticky, mucilaginous trails.*

This circumstance benefits the crustal organisms, since attached nutrients are thus readily available, and also the surrounding vascular plants. As with soil stability, this soil-enriching function is not dependent on the presence of living filaments, but only on the presence of sheath material.

Sheaths also offer protection to the organism from both abrasion and desiccation – especially important in dry, unstable soils. Perhaps equally important, the sheaths and the organisms they surround contribute a great deal of organic matter to soils in which they occur.

Their Nitrogen Fixing Role

Nitrogen fixation is another significant capability of many cyanobacteria. Vascular plants are unable to utilize nitrogen as it occurs in the atmosphere and are dependent on microbial organisms to reduce atmospheric nitrogen to a form they can use. This is especially important in desert ecosystems, where nitrogen levels are low and often limiting to the system's productivity. Cyanobacteria play an even more critical role in cold desert ecosystems, where symbiotic and heterotrophic bacterial fixers – often important contributors of fixed nitrogen – do not perform well.

Cyanobacteria, then, are basically nutritionally independent organisms, needing only light, atmospheric nitrogen, a few minerals, and water to survive. This, along with sheaths that give them the ability to stick to surfaces, stabilize soil particles, capture nutrients, and hold water, enables them to colonize areas of bare rock and soil, such as newly-formed land masses.

Their Role As Colonizers

This capacity of cyanobacteria can be seen today in areas such as Iceland and Hawaii, where they are the first to colonize lava flows and cinder cones. For all the above reasons, it is thought that these organisms probably were the first colonizers of earth's early land masses and were integral in the formation and stabilization of earth's earliest soils.

Production of weak acids by the cyanobacteria, as well as the trapping and holding of water next to the rock, would have accelerated the weathering of the parent material and the production of soil particles. The binding of newly-formed particles by the cyanobacteria's sticky sheaths, greatly increasing resistance to water and wind erosion, would have aided the formation of small soil pockets. These small pockets of soil would further accelerate the weathering process, as more water would be trapped and more substrate would be available for colonization by more cyanobacteria.

Unfortunately, human activities are generally incompatible with the presence and well-being of cyanobacterial crusts, whether the disruption comes directly through construction and recreational activities, or

Continued on page 4

mab notes

The *Biosphere Reserve Coordinating Committee*, (BRCC) held its first meeting March 26-27. The BRCC was established by the US/MAB National Committee in January to coordinate planning and development of the US Biosphere Reserve (BR) program. Seven federal agencies, the five MAB directorates, the Southern Appalachian MAB program, and The Nature Conservancy are represented on the committee. It agreed to convene a workshop later this year to bring together Committee members, BR managers, and outside scientists to develop a strategic plan for the US/BR program. It deferred consideration of a national workshop of BR managers, pending completion of the strategic plan.

The first and, so far, only institutionalized MAB regional program in the US, the *Southern Appalachian Man and the Biosphere Cooperative* (SAMAB) continues to stretch its wings. Although the IRS has not yet formally approved the SAMAB Foundation's nonprofit status, the Foundation has a bank account and is accepting contributions. The goal is eventually to fund most SAMAB projects through this Foundation.

The Cooperative has numerous projects underway or on the drawing board. A commission with local citizen input is studying ways that Pittman Center, a small community on the northwest border of Great Smoky Mountains NP, can develop economic alternatives to the strip development that has afflicted other tourist centers in the area. Land ownership, soils data, and other information are being entered into a geographic information system (GIS). North Carolina State University has agreed to do a computer analysis of viewsheds from various strategic points under various development scenarios, and the local planning commission has recommended prohibiting any new billboards and phasing out old ones.

A workshop, held at Asheville, NC, reviewed the state of knowledge about native economic plants of the region and discussed protection measures. Establishment of a local industry to grow these plants commercially is one possible way to conserve wild populations, but workshop participants felt that much more information on the present situation is needed before alternatives can be explored.

Late this summer a meeting will be held to educate public officials and others about the rapid spread of dogwood anthracnose, a fungal disease causing high mortality for which no effective control has been found. Flowering dogwood grows throughout most of the East and provides a spectacular spring show of white blossoms in the southern Appalachians. It is the basis of numerous "dogwood festivals."

Our Backyard Biosphere Reserve, a teacher's manual, is being used to develop an environmental education curriculum in public schools in Sevier County, TN. With assistance from SAMAB and the Alliance for Environmental Education, schools in the county are joining Econet, a satellite computer network that will allow exchange of information on EE programs with schools in California, Michigan, and elsewhere in the US. Links with European countries may become possible through the OECD (Organization of Economic Cooperation and Developmenmt).

Big Bend BR sees great potential for applying MAB/BR concepts both in association with the other two Chihuahuan Desert BRs and in the immediate Big Bend region. Managers from Big Bend, the Jornada Experimental Range in New Mexico, and Mapimi BR in Mexico met at Mapimi in February to discuss mutual interests and possible projects. After a meeting at Jornada next November they expect to produce concrete proposals.

Already, however, evaluation of proposed restoration of the endangered Bolson tortoise to Big Bend is underway. This large (up to 45 pounds) tortoise ranged much more widely during the Pleistocene but now is restricted to the Mapimi region of Mexico. It is speculated that aboriginal man hastened its demise over much of the original range, and capture for food has continued to decimate the population in Mexico. Suitable habitat in Big Bend has been identified and enough captive animals apparently exist in Arizona and Mexico to provide stock without depleting the wild population. The main issues remaining are to alleviate Big Bend area ranchers' concerns about burrowing and grass-eating by the tortoises, and approval by various Mexican and US agencies.

Phil Koepp, chief ranger at Big Bend, says he is excited by the possibilities of working with park neighbors to develop a BR approach to many other environmental issues. Nearby are a Texas wildlife management area of 100,000 acres and a state natural area that will reach 300,000 acres, besides some ranchers who are "ardent conservationists." Across the Rio Grande, Mexico contemplates creating a large national park or biosphere reserve. The land base and human attitudes seem favorable for cooperation.

At MAB/UNESCO in Paris, Jan. 23-26, 12 scientists from the USSR, China, Czechoslovakia, UK, USA, France, West Germany, and Canada discussed ways of setting up an *international network of sites* in BRs to study global change. They recommended selecting 20 to 40 BRs and initiating pilot projects to test the abilities of the network to conduct scientific research. Ray Herrmann, NPS; Caroline Bledsoe, National Science Foundation; Guillermo Mann, Conservation International; and Paul Risser, University of New Mexico, represented the US.

The international *biosphere reserve brochure* has been reprinted with an updated list of reserves. Copies may be had from the GPO Bookstore, 941 N. Capitol St., NE, Washington, DC 20401; (202) 783-3238. Stock No. 044-000-07277-0. $3 each. No bulk rate is available, but the MAB Secretariat hopes this can be arranged if orders show enough demand.

Dated March 20, 1990, a *status report on biosphere reserve programs* in each of the 24 biogeographical provinces and 12 coastal regions represented in the US is available from David Figlio, NPS Wildlife and Vegetation Division, PO Box 37127, Washington, DC 20013-7127; (202) 343-8135 or FTS 343-8135.

Napier Shelton, *Washington Office, NPS*

Microbiotic Crusts: *(Continued from page 3)*

indirectly through domesticated grazing animals or pollutants. The cyanobacterial fibers that confer such tensile strength to these crusts are no match for the compressional stress placed on them by footprints (cows or people) or by machinery, especially when the fibers are dry, and therefore brittle. Air pollutants, both from urban areas and from coal-fired power plants, significantly affect the physiological functioning of these crusts.

Human Needs Pose Threat

The arid West, where the crusts play such a critical role, is facing expanding human presence. With that, comes ever-increasing pressure to provide energy resources (such as coal, and oil shale), to provide locations for energy production (such as coal- and oil-fired power plants), and to provide locations for waste disposal (whether incinerators or landfills). These activities can be devastating to the microbiotic crusts, which are, in essence, the topsoil of most of the West. No research has been done on recovery rates of crusts after physiological disturbances by pollutants and so this remains unknown.

There is information on recovery from mechanical disturbances, of which there are two types: trampling, like that from hoof or foot traffic, that breaks up the crust but leaves pieces in place that may re-establish themselves; and total removal, as in road construction.

Recovery from trampling depends on the extent of trampling and the time of year it occurs. When they are dry, crusts are very brittle and easily broken up; the problem is not that anything is killed, but that the impacted area is destablized. Fiber connections are broken, both in sheaths containing living filaments and in those that are abandoned. For living filaments, repair and re-stabilization is possible only when moisture is present, so that if impacts occur just before or during dry times (of which there are plenty in the desert), re-establishment can be difficult.

Large Disturbances Hurt Most

All this is exacerbated when large areas are destabilized, as with grazing or wildfires, or when destabilization occurs as a continuous strip, such as vehicular or bicycle tracks. These situations leave areas highly susceptible to wind and water erosion. Wind not only blows pieces of the pulverized crust away, thereby preventing reattachment of pieces, but it also blows around the underlying loose soil, covering nearby crusts. Overland water flows carry loose material as well. Since crustal organisms need to phtosynthesize, burial can mean death.

When large sandy areas are impacted in dry periods, previously stable areas can become a series of moving sand dunes in a matter of only a few years. Continuous strips, e.g. those left by bicycles and motor vehicles, are highly susceptible to water erosion and channels form quickly, especially on slopes. These areas may never recover fully.

In situations where crusts have been removed, re-establishment is very slow and depends on the size of the disturbance. In sandy areas, under the best of circumstances and where the disturbance areas are small, a thin veneer – 2-4 mm thick – consisting of one or two species of cyanobacteria, may return in five to seven years. This compares to an undisturbed crust 50-100 mm or more thick, that may consist of 14-15 species of cyanobacteria, along with lichens, green algae, and other organisms. It is not known how resistant this thin layer is to erosion, especially those tremendous overland water flows that can occur in the desert. Damage to abandoned sheath material beneath the surface cannot be repaired but must be rebuilt slowly through years of cyanobacterial growth.

Artificial inoculation can significantly increase recovery rates, and should be an integral part of recovery plans for these areas.

Impacts on crusts occur in all arid land parks. Crusts in some parks are affected directly by livestock grazing allowed in those parks. All parks are affected by people, foot traffic, and various types of construction. Most parks, if not currently threatened by air pollution problems, could be in the near future. It poses a real challenge for managers of these parks to find ways to protect these crusts, given the host of factors that affect them and the important contributions they make.

Belnap is a Biologist with Canyonlands NP.

Renewable Gravel Sources for Road Maintenance in Denali NP&P

By Kenneth F. Karle

A 90 mile gravel road forms the main transportation corridor into Denali National Park and Preserve (DENA). Decisions by previous park managers not to pave this road were based on a desire to maintain a 'wilderness' quality to the road system. Also, it was felt that asphalt pavement might act as a hindrance to migrating wildlife within the park. As such, the gravel roadbed requires long-term material sources for annual maintenance and resurfacing. NPS requirements for in-park material sites impose special constraints upon managers considering source development. Perhaps the most important of these is that the site and method of excavation operations should lend themselves to as close a return to a natural condition as possible.

In response to the constraints of these criteria, the NPS has determined that alluvial floodplain sites will help meet the needs of replenishable gravel production in Denali NP&P. Because of its size, central location, and acceptable material quality, the Toklat River floodplain has been chosen by park engineers as a primary alluvial gravel removal site. However, numerous questions remain as to the quantities of gravel that may be mined without causing floodplain degradation, as well as to which removal methods will best promote a natural floodplain rehabilitation.

A research program was initiated in 1988 to provide a detailed and comprehensive analysis of the fluvial processes that occur near and in an alluvial floodplain gravel removal site. The determination of a safe yield for gravel removal and the proper placement of removal sites on the Toklat River floodplain required a two-fold approach.

Computer modeling was employed to note the effect of annual floods on various excavation configurations. A predictive computer sediment transport code was used for the modeling effort. With such a code, floodplain gravel removal sites may be modeled by altering river bed geometry, and noting replenishment in the form of surface elevation changes after the passage of a flood. In this manner, scrapes or pits for gravel removal may be designed for optimum size and location in order to assure a maximum replenishment rate.

The second approach method used in the study was analysis of experimental gravel pits excavated on the Toklat floodplain during the 1988 and 1989 summers. Three gravel removal sites, each significantly different in design, were analyzed for both qualitative and quantitative information regarding replenishment and site rehabilitation. The first two scrapes involved excavations placed longitudinally and laterally (respectively) to the direction of flow on the floodplain. Both scrapes eventually incurred natural replenishment and rehabilitation over a two year period. However, the third design tested offered much quicker rehabilitation results, and merits further investigation by park managers. A brief explanation of this scrape design follows.

Floodplain Gravel Excavations

The Toklat River is a 100 mi^2 watershed located on the northern side of the Alaska Range. The basin is extremely mountainous, with several peaks over 7000 feet high. In addition to snowmelt and rainfall, the Toklat is fed by glaciers, which cover two percent of the basin area. The river is extremely braided in nature, and is usually milky in color, due to the large amount of glacial silt in the water.

The third Toklat River test scrape, designed with the assistance of William Jackson, NPS Water Resources Division, was excavated on June 6 and 7, 1989. The idea behind this design was to try to mimic the braiding processes that occur on the gravel bed drainage course. To accomplish this, a main channel with substantial water flow was identified and surveyed. The excavated scrape was placed so that it mirrored a significant meander in the main channel. The scrape, in the form of a channel, matched in length, width, depth, and slope the channel it mirrored. Approximate dimensions of the excavated channel included an average width of 25 feet, depths of 2-3 feet, and a length of 430 feet, which resulted from the excavation of 1000 cubic yards of gravel. This excavated channel was connected both downstream and upstream to the existing channel, which allowed immediate inundation to occur. The design was implemented to provide an equal flow split between the existing and excavated channels. Upon completion, the designed channel pattern was essentially indistinguishable from natural channel patterns. To monitor this scrape, six cross-sections were located along the test area, and level surveys were used to keep track of elevation changes in the original and excavated channels. These cross-sections were surveyed June 5 and 6 (time of excavation), July 15, and Sept. 12, 1989.

Aesthetic healing of the excavated scrape was observed to begin almost immediately following streamflow inundation. Even at relatively low flow conditions, scour and deposition of streambed materials was significant enough to erase most signs of heavy equipment operations in and near the excavated channel within a two-week period. By the end of the first four weeks, casual observers unfamiliar with the project could not identify the test channel as a human-engineered excavation.

Though significant aesthetic healing processes occurred soon after excavation, substantial gravel deposition and replenishment did not occur until much later in the summer. This may be attributed to significantly larger streamflows on the west side of the Toklat drainage course, which took place from the beginning of August through the middle of September.

By Sept. 12, topography changes in the drainage course were so substantial that the excavated channel was completely obliterated. From the surveys, it is roughly estimated that at least 77 percent of the removed gravel in the excavation was replenished.

Conclusions

Based on the study results, it would appear that extraction design based on mimicking natural channels on a braided drainage course will encourage rapid healing and gravel replenishment. It should be noted that terms such as 'healing' and even 'replenishment' are difficult to quantify, and that estimates of replenished gravel (such as 77%) should be used with caution, and perhaps only in terms of general trends.

Additional hydrologic studies of the Toklat basin are continuing. A complete analysis, based on both empirical observations and mathematical modeling, should allow NPS planners to formulate a practical, yet conservative, gravel extraction management plan to meet park needs while vigorously protecting park resources and promoting rapid site rehabilitation.

Karle is a Physical Science Technician at Denali NP.



***The Toklat River** study site, looking upstream (South).*

Spotted Owls in National Parks:

By Douglas B. Houston

The northern spotted owl *(Strix occidentalis caurina)* occupies forests from southern British Columbia to Marin Co. California. Management of this handsome, demure appearing, creature has been a contentious issue in the Pacific Northwest. The bird inhabits coniferous forests that exhibit a particular structure, notably: multilayered, multispecies canopies dominated by large overstory trees showing moderate to high canopy closure; a high incidence of large trees with cavities, broken tops and other signs of "decadence"; numerous large snags, and heavy accumulations of logs. These conditions are most commonly, but not exclusively, associated with "old-growth" forests – and therein lies the rub.

Old forests are being harvested very rapidly, thereby eliminating large areas of suitable owl habitat and leaving much of the remainder as fragmented, isolated stands. Spectacular legal battles have been waged recently among environmental groups, federal land management agencies, and timber interests over how much owl habitat should be maintained on public lands. These *owl wars* led to the establishment, in 1989, of an Interagency Scientific Committee[1] to address the conservation of the bird. The Committee, headed by USFS Biologist Jack W. Thomas, was charged with developing "... a scientifically credible conservation strategy" for the owl.

I represented the National Park Service at the deliberations of the committee[2] from October 1989 until April 1990, when the strategy was made public[3]. These activities represented the most intensive, group scientific effort I have ever been involved with. The team of 17 biologists worked for 6 months to muster all relevant information on the biology of the owl, and then applied this knowledge to produce an on-the-ground, map-based, conservation plan.

The purpose of this note is to outline the process used by the team in deriving the conservation strategy (because it may serve as a blueprint elsewhere), to discuss the impact of the plan on park management, and to offer some observations on the relative quality of NPS baseline data.

Sideboards and Processes

The committee adopted certain operating sideboards, four of which are relevant here[4]:

1. A successful strategy will be rooted in the philosophy embodied in the National Forest Management Act which requires Forests to maintain viable populations of native species that are well distributed.

2. All land ownerships will be considered in the conservation strategy.

3. "Hands on" management of habitats and animals will be considered, i.e., transplanting owls, modifying silvicultural prescriptions, etc.

4. Although the spotted owl issue is, to some degree, a surrogate for the old-growth forest issue, i.e., how much old-growth shall be preserved, where, and in what form – we will focus strictly on questions of spotted owl population viability across its occupied range.

The process by which the team obtained, examined, and interpreted information was completely open. Anyone with information was welcome to address the group, to participate in discussions, etc. The open-door policy lasted until the team began to prepare the final report, the last month of the 6 month process. Moreover, much of the report consists of appendices that should allow anyone to track the logic and steps which led the team to their conclusions. Finally, a draft was submitted for peer review by scientists selected by the presidents of five professional societies[5].

The procedures followed in designing the strategy are noteworthy. All relevant literature on the owl was acquired, reviewed, and synthesized. Virtually everyone conducting research or monitoring the status of owls made presentations and supplied data. Owl habitats across 3 states were examined during field trips. The committee also sponsored three workshops: 1) Field biologists experienced with owl biology appraised several proposed conservation strategies based upon their knowledge of landscapes and owls; 2) Silviculturalists and forest ecologists explored silvicultural alternatives to enhance owl habitat in managed forests; 3) Conservation biologists and landscape ecologists critiqued the evolving strategy for owls in light of their experience and knowledge of applicable theory. The team also evaluated the current quality and consistency of management by interviewing field personnel on National Forests and BLM Districts.

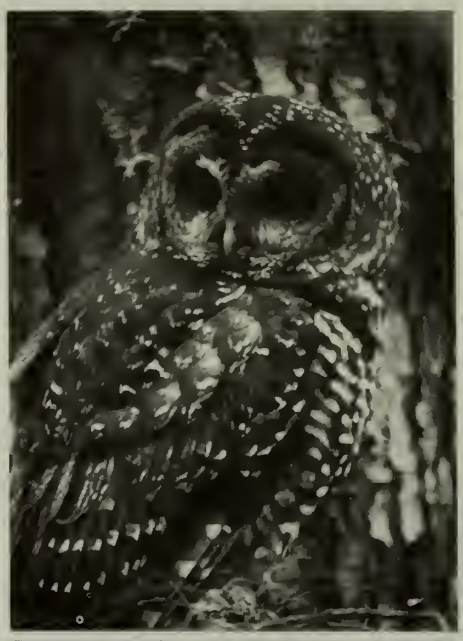
Synthesis of the information led the team to conclude that a conservation strategy was indeed warranted: the bird was imperiled over significant portions of its range[6]. The committee proposed a two-part strategy. In the first stage, steps were taken to ensure that adequate amounts of habitat were protected and well distributed to provide for the owl's long term survival. Large blocks of suitable habitat, *Habitat Conservation Areas* (HCAs), were proposed throughout the bird's range. The second stage calls for research and monitoring to test the adequacy of the strategy and to seek ways to produce and sustain suitable owl habitat in the managed forests (i.e., outside the HCAs). Knowledge gained in the second stage will be used to alter or replace habitat conservation plans prescribed in the first stage, but only if the modified strategy provides adequately for the owl.

The rationale for the size and spacing of HCAs drew heavily from demographic studies, modeling of owl extinction probabilities in differently arranged landscapes, and inferences from extinction rates of small populations of other birds throughout the world. HCAs capable of providing for 20 or more interacting pairs of owls spaced no more than 12 miles apart (based on studies of dispersal distances of juvenile owls) formed the basis for the strategy. Where geography, land ownership patterns, or past logging precluded large HCAs, smaller ones were to be established closer together. Dedicated corridors for owl dispersal among the HCAs were deemed unnecessary, provided forests in the intervening landscape matrix met certain structural criteria. All logging in HCAs was to cease.

Once this rule set was established, maps were drawn for Washington, Oregon, and northern California, and checked for consistency with the guidelines. Not surprisingly, "real world" landscapes often forced modification of the idealized design. At least 10 iterations of each map were necessary before tests produced the size and spatial arrangements deemed satisfactory. The committee estimated that the system of HCAs proposed for federal lands now contains about 1465 pairs of owls. As young, previously cutover, forests in HCAs mature, these areas might support 1750 pairs. This brief introduction to the complex, map-based strategy is necessarily oversimplified – the report must be read to gain full understanding.

Owls in Parks

The spotted owl is known to occur in 8 NPS areas from North Cascades to Muir Woods (table 1). The bird may also occupy the Whiskeytown NRA because it is known to occur in that region of California. NPS areas *may* altogether contain about 570,000 acres of suitable owl habitat, but these estimates should be regarded as crude first approximations, particularly for the larger parks. The configuration and quality of habitat differ markedly among the areas. Habitat in the large, mountain parks of Washington and Oregon occurs in blocks at low elevations around the perimeters of the parks, separated by unsuitable high elevation areas in the interior. Overall, NPS areas contain roughly 7-8 percent of the existing owl habitat and *may support* 100 or more pairs of owls (in contrast, about 74 percent of the owl habitat occurs on National Forests). The largest single park population may occur in Olympic NP; estimated conservatively by the park staff at 40 pairs. The committee, using additional information from Landsat, estimated the Olympic population at 60-80 pairs. Other parks have populations ranging from perhaps 1 to 20 pairs.



The Northern Spotted Owl *(Strix occidentalis caurina)*

Several things are apparent from the information in table 1. First, the NPS is a relatively minor player in the overall business of conserving the northern spotted owl. More importantly, conservation biology suggests that the numbers of owls in National Parks are too small for the species to persist over time if isolated from birds in surrounding areas because of habitat fragmentation. Considerations of physiography and size of parks in Washington and Oregon, for example, suggest that survival of the birds in these areas is closely tied to the welfare of owls on surrounding lands. Each park contains owls at the upper elevational limit of their distribution, and North Cascades and Olympic also approach the species' northern geographic-range limits. Spotted owls that exist under such biogeographic constraints may be particularly susceptible to wide fluctuations in abundance over time, with correspondingly increasing probabilities of extinction. Spotted owl populations on the Olympic Peninsula, including Olympic NP, already appear to be isolated from other populations and are thought to be especially vulnerable.

Report of the Interagency Committee

The Committee and the Parks

The committee viewed the management objectives for National Parks as generally compatible with conserving owls. They recognized the importance of maintaining ecological processes (as opposed to preserving particular biological states), and accepted single species management as generally inappropriate.

The committee showed particular concern for the welfare of NPS owls; parts of six Park Service units are within proposed HCAs (table 1). Additionally, an HCA abuts the southwest corner of Crater Lake.

What does inclusion in an HCA mean to park management, given the committee's apparent acceptance of broad NPS objectives? Overall, in my view, HCA designation will have relatively little effect on park operations. Certain activites, however, are prohibited in the management prescriptions for HCAs: 1) timber harvest, including firewood cutting and salvage of downed trees; 2) road construction, except when no feasible alternatives exist.

A fire plan is also to be prepared for each HCA, and the NPS was asked by the committee to review existing fire plans for compatibility with owl management objectives. Prescribed fire was recognized by the committee as being important in maintaining the structural diversity of some forest communities occupied by owls. Intense stand-replacement fires obviously can do bad things to owl habitat in the short term. Over the long term, in my view, maintaining mosaics of different-aged forest communities (which differ in fuel loading and susceptibility to burning) may be important in reducing probability of large, catastrophic fires[7].

I judge that the NPS will receive considerable pressure to survey owls in parks. Monitoring the status of owls annually will be required in some HCAs as part of the adaptive management strategy. Inventory and monitoring efforts will be closely coordinated among agencies; this will require NPS to develop Geographic Information System capabilities that are compatible with those of other agencies. Parks may also receive more attention as owl research sites; Redwood NP, for example, has a unique opportunity to document the stand structure and age at which owls first recolonize second-growth redwood forests.

NPS Baseline Data

Overall, the quality of information that the NPS could bring to bear on the owl issue was relatively poor, compared to that of other federal and state agencies. This included not only data on owls, but reliable, accessible information on forest distribution and structure. (There were bright exceptions; Mount Rainier, for example, has wonderful information on forests.) The committee noted that the "... inadequacies of information on the status of the owl and its habitat in the National Parks, particularly the Olympic NP, have presented problems to us in developing the conservation strategy." In response, it might be argued that since park management is generally compatible with owls, and all parks certainly have management issues that are seemingly more pressing, there was little need heretofore to acquire such information. This granted, the counterargument still lacks bite, and underscores fundamental shortcomings, I believe, in our inventory and monitoring programs.

Implementation?

Whether or not the plan, or any part thereof, is implemented remains to be determined. Two things are certain: 1) Watching this issue play out to resolution will be extremely interesting; 2) We on the team found the effort challenging and educational.

The postscript to the report offers an appropriate perspective: "We were asked to do a scientifically credible job of producing a conservation strategy for the northern spotted owl. We have done our best and are satisfied with our efforts. We have proposed. It is for others – agency administrators and elected officials and the people whom they serve – to dispose. That is the system prescribed in law. It seems to us a good one. We can live with that."

Houston is a Research Biologist with the NPS Pacific Northwest Region, based at Olympic NP.

Table 1. Areas (1000s of acres), distribution, and results of spotted owl surveys on NPS lands

STATE Locality	Estimated area of owl habitat[a]	Habitat[b] distribution	Owl pairs[c] Known	Owl pairs[c] Estimated	Owl Inventories[d]	HCA's[e]
WASHINGTON						
North Cascades	126	1	0	20	P	Y
Mt. Rainier	31	1	8	?	P	Y
Olympic	323	1	12	40	P	Y
OREGON						
Crater Lake	50	1	4	14	P	N
Oregon Caves	0.5	3	1	1	C	N
CALIFORNIA						
Redwood	20	2	0	5	U	Y
Pt. Reyes	16	2	2	4	P	Y
Muir Woods	0.5	3	1	1	C	Y
Whiskeytown	4?	?	0	?	U	N

[a] Generally gross estimates subject to revision, small areas excepted.

[b] 1 = Habitat around low elevation perimeter and separated into blocks by mountains or lakes in the core of the park; 2 = blocks of contiguous low elevation habitat; 3 = essentially all suitable habitat.

[c] Known pairs are those located from 1985 to 1989. Estimates are habitat capability extrapolations, usually from FS or FWS Status Review Supplements.

[d] P = Partial surveys with large backcountry areas still unsurveyed; C = complete surveys; and U = unsurveyed lands.

[e] Y = Part of the area within one or more designated HCA's.

Notes and References

1. *Agencies involved were: U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service.*
2. *The six member core committee consisted of: J.W. Thomas, E.D. Forsman, B.R. Noon, and J. Verner of USFS; J.B. Lint of BLM; and E.C. Meslow of USFWS. The overall team included: (1) a representative from each of the 3 states, (2) advisor/participants representing timber interests, environmental groups, and academia, and (3) technical staff/advisors from the federal agencies. On the team were 17 biologists (12 of whom were experienced in dealing with the biology and management of the owl). All team members participated fully in all aspects of the effort, with the core committee responsible for signing the final report.*
3. *Thomas, J.W. et al. 1990. A conservation strategy for the northern spotted owl. Interagency committee to address the conservation of the northern spotted owl. Portland, Oregon, April, 1990. 458 pp.*
4. *Some of what follows is taken nearly verbatum from the committee's report, with permission from J.W. Thomas.*
5. *Reviewers were drawn from: American Ornithologists Union, Ecological Society of America, Society for Conservation Biology, Society of American Foresters, The Wildlife Society.*
6. *The decision whether or not to list the owl under provisions of the Endangered Species Act is currently being considered by a committee of USFWS biologists; this was not the responsibility of the Thomas team.*
7. *See for example, Romme, W.H. and D.G. Despain. 1989. Historical perspective on the Yellowstone fires of 1988. Bioscience 39:695-698.*

I thank Bruce Moorhead and Janis Burger for reviews of this manuscript.

Howell's Final Quote Seems So Apt Here!

An article by Judd Howell, Wildlife Ecologist with the Golden Gate NRA in San Francisco, appearing in the current issue of the George Wright Society's FORUM, deals with the natural resource values of the broader community and the roles of key individuals in opposing NPS proposals to remove the Australian Blue Gum (an alien species) from 16 locations in the Recreation Area. The paper explores the formation and mobilization of Marin County citizens into a group named POET (for Protect Our Eucalyptus Trees) and discusses a widespread public perception of federal and state agencies as "elites, with exclusive access to specific natural resource knowledge." (See Bader article, this issue).

"Knowledge shared in joint planning," Howell suggests, "can result in cooperation and in maintaining the trust in information developed by agency planning groups." One segment of Howell's final paragraph reads in part:

"... people seemed to believe that scientific knowledge sprang out of the democratic process of open debate, rather than through the exactitude of the scientific process. Too often in the public arena, scientific information was misrepresented for purposes of persuasion. (Granted that management must sometimes make decisions without all the facts,) still the facts must withstand the rigors of science. At some point in this process we must say: **'Persuade me not; before you lies the truth, bloodied but unaltered by the battle."'**

Resource Managers and the Courts: A Decision-making Process Designed to Achieve Public Confidence

By Harry R. Bader

To the overworked natural resource manager on public lands it may often seem as though courts take a special delight in crafting anxieties that would render even Dante speechless. However, courts do not actively seek to entangle their own limited resources in the highly technical and specialized field of resource management.

The judiciary usually becomes involved because an error within the decision-making process has been detected by an aggrieved interest group. With standing in hand, the group may then seize this transgression in the hope of eventually forcing a substantive result through the procedural door.

The purpose of this comment is to acquaint the natural resource manager, whether s/he be associated with NPS, USFS, BLM, or the USFWS, with some of the fundamental principles guiding judicial review of agency decisions. Armed with this knowledge, our nation's natural resource stewards can create better decision-making processes, which reduce exposure to unwanted judicial intervention.

Bureaucratic agencies, it is no revelation, are beheld with a certain degree of suspicion. Their broad grants of authority, coupled with their insulation from the traditional avenues of democratic process, create an operational milieu where discretion may be motivated by the vicissitudes of bias or favoritism toward particular special interests.

Juxtaposed with this suspicion however, is the recognition that administrative agencies have institutional strengths that demand deference. Agencies are uniquely suited to handle complex problems because of their specialized personnel and the expertise that accrues from repeated exposure to certain types of issues.

There are many kinds of agency conduct which demand various levels of judicial scrutiny to insure fairness and accuracy. The Administrative Procedure Act and the judiciary distinguish between formal and informal acitivites, and between decisions premised upon findings of law or fact. (5 U.S.C.pp 551-706). The majority of natural resource decisions by agency field managers consist of informal discretionary actions based upon a finding of fact taken in the regular course of their normal duties.

These are the decisions that lead to a particular forest tract being harvested or a specific access road being constructed; these are the decisions that generate alternatives in plans and impact statements, or decree whether certain conduct may harm an endangered species. Sometimes the decisions may be as simple as deciding where to place a new public access cabin or trail. Such decisions confront resource managers every week, and these same decisions serve as the basis for innumerable lawsuits, which lead to costly delays, stifled initiative, and personnel demoralization. This comment addresses these informal discretionary decisions and the proper process for generating them.

Because the Administrative Procedure Act provides only a dim beacon for guidance, the courts have crafted innovative techniques for reviewing agency conduct. The techniques are diverse and go by many names, but are often referred to collectively as "the hard look doctrine." (Sunstein, "Deregulation and the Hard Look Doctrine," I983 S.Ct. Review 177).

In reviewing agency conduct, the goal of the judiciary is to establish a decision-making process that assures a reasoned decision which can stand up to public and scientific scrutiny. (Ethyl Corp. v. EPA 541 F.2d 1. 66, 1976). Therefore, a judge will overturn an agency decision only if it is arbitrary, capricious, or an abuse of discretion. (Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council 435 U.S. 519, 545-546 and 548, 1978, and Citizens to Preserve Overton Park v. Volpe 28 L.Ed 136, 153, 1971).

Because the focus is procedural, it is possible for a decision to be invalidated, no matter how scientifically correct under the circumstances. On the other hand, if a resource manager follows the demands of Hard Look doctrine, the decision will be accepted, even if the court disagrees with the substantive outcome. The only role for a court is to ensure that the agency has taken a hard look at the salient facts; it cannot interject itself within the area of discretion as to which action should be taken. (Kleppe v. Sierra Club 427 U.S. 390 at 410, 1976). For example, alternative selection from a properly prepared environmental impact statement cannot be dictated by a judge. That substantive decision resides within the scope of the agency's discretion. The judicial role rests solely upon determining whether the EIS is a full disclosure document, generated in good faith after a detailed inquiry. This type of review is purely procedural.

Judicial review is intended to build confidence in the legitimacy of government authority by insuring an honest and earnest process. Review "underlines the court's rigorous insistence on the need for articulated rationale and reflective findings rather than whim, misplaced zeal, or improper influence. (Greater Boston Television Corp. v. FCC 44 F.2d 841, 851-852, 1970).

In order to realize legitimacy, judicial review makes four principal demands. (Sunstein, "Deregulation and the Hard Look Doctrine," 1983 S.Ct. Review 177, 181-182). Agencies must (1) offer detailed explanations for their decisions, (2) justify any departures from past decisions under similar circumstances, (3) consider a set of alternatives before making decisions, and (4) involve the public whose interests are affected wherever appropriate.

The following checklist, addressing concerns in the first three components, is derived from various requirements articulated from 23 federal cases, most involving natural resource issues.* The 12 elements contained here should be considered as essential steps for a legitimate decision building process and adhered to in every decision regarding resource management, whether or not one expects controversy. All 12 elements focus upon the concept of full disclosure and reasoned inquiry as a means to faciltitate public understanding and acceptance of agency logic and considerations.

Checklist for Decision-Makers

1. The goals and objectives to be achieved by the decision must first be identified.

2. The agency's general policy mandates, prior decisions, and predispositions, as they relate to the matter at hand, must be explained.

3. The facts that are considered in resolving the problem, and why they are relevant to the problem, must be expressed.

4. The criteria used for decision-making and their relative weights must be articulated and justified.

5. Analysis techniques and methods must be explained.

6. All pertinent assumptions and areas of uncertainty (or where information is incomplete) must be disclosed.

7. The agency must articulate a rational connection between the facts found and the choice made.

8. The decision-maker must demonstrate that the choice selected will achieve the goals and objectives previously stipulated (Efficacy).

9. The decision-maker must show that the choice selected is the best possible solution available from a set of viable options (Supremacy).

10. The agency must demonstrate, when competing user groups are involved, that it has made a good faith effort to distribute equitably the benefits and burdens accruing from its decision.

11. The solution must encompass an internal system of self evaluation and review so that the decision can be modified as circumstances dictate.

12. If the decision marks a change from prior agency conduct in similar situations, a reasoned analysis indicating what factors brought about the change, and why, must be provided.

The 12 elements that comprise this checklist facilitate legitimacy concerns because the elements tend to (1) eliminate ambiguity and vagueness, inconsistency, and the cursory statements that can mask favoratism and bias, and (2) reinforce a good faith effort to ascertain truth, achieve accuracy, and find the most effective answer to a problem. Legitimacy concerns are extremely important because decisions that affect resource allocations such as timber, water, wildlife, minerals, open space, and recreation management go straight to the heart of "personhood values."

"Personhood" Values

Human beings are cognizing and goal-directed organisms. Attempts at needs satisfaction involve the ordering of one's own personal environment in an effort to maximize creative options and freedom of choice. These options and choices create the opportunities for self-development (personhood). To achieve this goal, an individual needs some control over personal activities-- the assurance that environmental conditions are stable enough to allow a person to make plans, investments, and commitments. In short, people must be able to rely on the assumption that society and government will respect these expectations.

A chosen lifestyle can provide a unique sense of personal fulfillment. Offer a farmer, a miner, a fisherman or a lumberjack work on an assembly line for a higher wage and many would reject the offer. Opportunities for recreation, such as hiking, camping, and wildlife viewing, also are essential to the human soul and contribute to the creation of individual identity.

Thus, expectations based upon personhood values give rise to a moral claim stronger than other expectations. A resource management decision that tends to trample upon personhood expectations must be especially carefully arrived at. Any perception that such decisions are cavalierly made, carelessly reasoned, or subject to favoratism and bias, calls into question the legitimacy of government authority. When an agency frustrates personhood values, the process that developed the course of action in question must be beyond reproach–open, broad-searching, rational, and consistent. Nothing less must be tolerated; the social stakes are too great.

Continued on page 9

Global Issues, Natural Areas

A global issues symposium, "Natural Areas and Yosemite: Prospects for the Future," is scheduled for Oct. 13-19, 1990 at Yosemite NP (Oct. 13-14) and at the Sheraton Conference Center in Concord, CA (Oct. 15-19) as a highlight of the Yosemite Centennial Celebration.

Sponsored by Yosemite NP and the Natural Areas Association in cooperation with the Yosemite Fund, the gathering will look backwards to the establishment of Yosemite NP in 1890 and ahead to the future of parks and natural areas in the year 2090. Resource managers, scientists, agency administratsors, students, conservationists, all will find opportunities to learn and to contribute at the gathering.

Six plenary sessions will feature speakers from government, academia, national and international conservation organizationsj. The final keynote address, by Gilbert Grosvenor, president of the National Geographic Society, will be broadcast on National Public Radio. Field trips will take participants to San Francisco Bay Area natural areas such as Muir Woods, UC Botanic Gardens, Angel Island, Ring Mountain, Point Reyes, Grizzly Island, and other such areas.

Contact Coordinator, NA/Yosemite Centennial Symposium, Golden Gate NRA, Fort Mason Bldg. 201, San Francisco, CA 94123.

Biodiversity Training Course

"Managing for Biological Diversity" is the title of an NPS training course to be held in San Francisco Sept. 10-14, 1990. Course designer and coordinator Dick Cunningham, of the NPS Western Regional office, is targeting the course at park managers, scientists, resource managers, and interpreters.

Managers and Courts

(Continued from page 8)

Because of the high social costs involved in frustrated public expectations, courts review agency decisions to insure that agencies conduct themselves professionally, fairly, and with impeccable integrity. The checklist contained in this comment may lead to better decisions, which pre-empt the opportunity for judicial review. It is designed to win acceptance and respect from those whom resource decisions impact.

> "When administrators provide a framework for principled decision-making, the result will be to diminish the importance of judicial review by enhancing the integrity of the process..."
>
> *Ethyl Corp. v. EPA*
> 541 F. 2d 1, 67 (1976).

Bader is a Professor of Environmental Law at U/AK, Fairbanks, and a member of the Sea Grant legal team.

*National Audubon Soc. v. Hester 801 F.2d 405 and 627 F.Supp. 1419 (1986); Sierra Club v. Clark 755 F.2d 608 (1985); Friends of Endangered Species v. Jantzen 760 F.2d 976 (1985); Village of False Pass v. Clark 733 F.2d 605 (1984); Sierra Club v. Clark 577 F. Supp. 783 (1984); Baltimore Gas & Electric v. NRDC 462 U.S. 87 (1983); Motor Vehicle Mftr. Assoc. v. State Farm Mutual 103 S. Ct. 2856 (1983); Humane Society v. Watt 551 F. Supp. 710 (1982); Cabinet Mts. Wilderness v. Peterson 685 F. 2d 678 (1982); Cayman Turtle Farm v. Andrus 478 F. Supp. 125 (1979); Vermont Yankee Nuclear Power Corp. v. NRDC 435 U.S. 519 (1978); Connor v. Andrus 453 F. Supp. 1037 (1978); Palila v. Hawaii Dept. of Land and Natural Resources 471 F. Supp. 985 (1979); Environmental Defense Fund v. Blum 458 F. Supp. 650 (1978); Local 777 of the Democratic Union v. NLRB 603 F.2d 862 (1978); Defenders of Wildlife v. Andrus 428 F.Supp. 167 (1977); Ethyl Corp. v. EPA 541 F. 2d 1 (1976); U.S. v. Allegheny-Ludlun Steel 406 U.S. 742 (1972); Environmental Defense Fund v. Ruckelshaus 439 F. 2d 584 (1971); Citizens to Preserve Overton Park v. Volpe 28 L.Ed. 2d 136 (1971); Greater Boston Television Corp. v. FCC 444 F 2d 841 (1970).

meetings of interest

1990

Sept. 10-14, MANAGING FOR BIOLOGICAL DIVERSITY, a training course for NPS research scientists, resource managers and interpreters, in San Francisco. Contact: Dick Cunningham, NPS Western Reg. Office, (415) 556-3184.

Sept. 13-15, FORT UNION FUR TRADE SYMPOSIUM, a day of historic review and presentations of the Fort's reconstruction, with a historic tour of the confluence area; sponsored by Friends of Fort Union Trading Post. Contact: Fort Union Trading Post National Historic Site, Buford Route, Williston, ND 58801. (701) 572-9083.

Oct. 3-5, ECOLOGY AND PLANNING: THE LANDSCAPE DIMENSION, at the Red Lion Inn, Sacramento, CA (second of a series – see p. **??**). Sponsored by U/Cal/Davis Extension, featuring fundamentals and techniques of landscape ecology and case study applications to specific land use problems. Contact: Dana Abell, Univ. Extension, U/Cal Davis, 95616.

Oct. 13-19, NATURAL AREAS/YOSEMITE CENTENNIAL SYMPOSIUM, at Yosemite NP and the San Francisco Bay area; jointly sponsored by the Park and the Natural Areas Assn., "Natural Areas and Yosemite: Prospects for the Future;" contact: Coordinator, Natural Areas/Yosemite Symposium, GGNRA, Fort Mason Bldg., #201, San Francisco, CA 94123; (415) 556-1009; FAX (415) 556-1399.

Nov. 12-17, SIXTH CONFERENCE ON RESEARCH IN THE NATIONAL PARKS AND EQUIVALENT RESERVES, at the Westin Paso del Norte Hotel, El Paso, TX; Contact: Conference Committee at (415) 556-1866.

Nov. 27-29, NEW PERSPECTIVES FOR WATERSHED MANAGEMENT; Balancing Long-Term Sustainability With Cumulative Environmental Change, sponsored by U/WA Center for Streamside Studies and OR/St/U Col. of Forestry, at U/WA, Seattle. Contact: Continuing Education, Coll. of Forest Resources, AR-10, U/WA, Seattle, WA 98195 (206) 543-0867.

1991

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

Nov. 4-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL, in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Contact: Gabriel Cherem, EMU Geography & Biology, Ypsilanti, MI 48197; (313) 487-0218, or Ray Tabata, UH Sea Grant, (808) 948-3191.

Tourism Is Conference Theme

"Joining Hands for Quality Tourism: Interpretation, Preservation, and the Travel Industry" is the theme for the Third Global Congress of Heritage Interpretation International, to be held Nov. 4-8, 1991, in Honolulu, HI. Proposed topics should fall into one of the six Congress subthemes of: preserving environments and cultures; guided travel experiences; interpreting across cultures; interpreting communities; applying appropriate techniques; and building partnerships.

More information and program announcements are available from Dr.Gabe Cherem or Ray Tabata, Conference Chair, UH Sea Grant, 1000 Pope Rd., MSB 226, Honolulu, HI 96822 USA, (808) 948-8191; FAX (808) 955-6950.

Landscape Ecology and Planning

"Ecology and Planning: The Landscape Dimension" is the second conference in the series Ecology and Planning offered by U/Cal Davis's University Extension Service. It will be held Oct. 3-5, 1990 at the Red Lion Inn in Sacramento.

The conference will cover fundamentals and techniques of landscape ecology, especailly as they apply to forest management, regional planning, resource management, and land restoration. It should be especially helpful to those who seek to bring ecology into the decision-making process on the use of land and resources. Contact is Susan Berman at (916) 757-8777.

Watershed Management Perspectives

The University of Washington's Center for Streamside Studies, together with Oregon State University's College of Forestry, will co-sponsor a symposium, "New Perspectives for Watershed Management: Balancing Long-Term Sustainability with Cumulative Environmental Change," on the U/WA campus in Seattle November 27-29, 1990. The underlying theme is the linking of environmental integrity to watershed management and human needs. Symposium objectives are to:

- present the current status of watershed research and regional models;
- identify indicators of environmental changes at different scales;
- investigate new technical tools and system models; and
- explore how to relate the tools to management and human needs.

Posters are solicited for topics related to research and management activities of watershed management, including range utilization, urbanization, old growth harvest, maintenance of biodiversity, and long-term productivity of agricultural and forested lands. Submit two copies of a 200-word abstract by Sept. 1, 1990, to George Ice, Technical Poster Coordinator, NCASI, PO Box 458, Corvallis, OR 97339.

Contact, Continuing Education, College of Forest Resources, AR-10, U/WA, Seattle, WA 98195 (206) 543-0867.

Does Global Change Evidence Signal Biological Catastrophe?

Editor's Note: A battery of world class scientists addressed a two day conference at U/CA/Davis recently, evoking the following report from Tom Stohlgren, Ecologist with the NPS/CPSU at U/CA/Davis.

On April 30 and May 1, I heard world renowned experts address two major questions: (1) What is the evidence for global change?, and (2) How is life on earth responding to global change? Because their comments are pertinent to the proposed NPS Global Change Program, I have summarized them briefly.

Dr. Paul J. Crutzen, atmospheric chemist and Executive Director of the Max Planck Institute for Chemistry, West Germany, displayed convincing evidence of recent changes in the planet's atmosphere. He estimates a doubling of tropospheric ozone in the Northern Hemisphere in the past century. Debate, he said, should no longer focus on whether global temperatures will rapidly change, but on what combination of interactions (e.g. increased penetration of ultraviolet radiation, with increased CO2, with changes in precipitation, etc.) will impact the earth's inhabitants. He stressed that CFCs (chlorofluorcarbons) released into the atmosphere today may not reach an equilibrium state for more than a century. Although we may internationally reduce CFC production by 50 percent, a reduction of at least 80 percent may be necessary to reduce the rate of further atmosphere degradation to the current rate of degradation.

Dr. Michael I. Budyko of the State Hydrological Institute, Leningrad, USSR, spoke for international cooperation to detect and predict climate change impacts. He showed that empirical data from many areas must be synthesized to detect trends. He also suggested that the strengths (i.e. computer modeling by US scientists, empirical data gathering by USSR scientists) could be maximized by sharing technique developments and data.

Dr. Paul E. Waggoner from the Connecticut Agricultural Experiment Station in New Haven, emphasized the potential impacts of global climate change to California. Californians consume one quarter of the annual fresh water produced in the continental US. He claimed over 90 percent goes to agriculture. Even slight reductions in precipitation amount could reduce groundwater storage, decrease water use efficiency by plants, and increase salinization of cropland soils. His talk helped me focus on the role many national parks play as primary watersheds for agricultural districts downstream.

Dr. Vernon H. Heywood of the IUCN – the World Conservation Union – United Kingdom, suggested we focus more effort on protecting species diversity, particularly plant species. He showed how alien plant species invasions are drastically changing local habitats and microclimates. Together, these invasions are profoundly affecting our efforts to preserve the biologogical diversity present only two centuries ago. Dr. Heywood suggested increasing our efforts to protect genetic diversity as well – focusing on small, isolated plant populations all over the globe.

Dr. Daniel Simberloff of Florida State University, drew upon the fable of the elephant (in this case, habitat fragmentation) and the flea (climate change). He asked whether, if the elephant kills a person, does it really matter if the flea also bites said person? He cited forest destruction in the past 200 years. Over 40 percent of wet tropical rain forests are gone, the rest is being cut at a rate of 1 percent a year. Old growth forests in the Pacific Northwest once covered 19 million acres; now they occupy only 2.5 to 3.8 million acres, primarily on USFS lands in Oregon, and are being cut at 2.5 percent per year – a faster rate than tropical forests.

In another US example, southeastern long leaf pine, which covered 70 million acres 300 years ago, has been systematically reduced to only 1,500 acres; thus, it was cut at about 5 percent per year. Along with forest destruction and habitat fragmentation comes the loss of biological diversity and landscapes that may never recover due to invasion of alien species, urban development, etc. Dr. Simberloff stressed the need to inventory resources and assess the possible impacts to all remaining fragments (small parks and large?) in light of continued habitat fragmentation compounded by climate change stresses.

Dr. William C. Clark from Harvard's John F. Kennedy School of Government spoke on "Managing Global Climate Change." He noted that in the past 100 years, the human population increased 300 percent and that agricultural productivity and energy production were up 500 and 2,500 percent respectively for that same period. Forest cover, however, *decreased* 15 percent, atmospheric CO2 and CH4 increased 100 percent each, and the flux of zinc and lead increased 300 and 1,800 percent respectively. Dr. Clark added that more than 70,000 new synthetic chemicals in use today were virtually unknown 100 years ago.

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Global Change Sites Selected

On Feb. 27, 1990, the Director announced the National Park Service's Global Change program. This announcement included a call for park-based bioregional areas to submit statements of capabilities and research interest for inclusion as core areas in the program. To evaluate the Capabilities and Interest Statements of the 27 potential core research areas that submitted proposals, the NPS convened a workshop in New Orleans, the week of May 14. At the workshop, representatives for the candidate areas presented their areas' capabilities and research interests to the NPS Global Change Program Committee (GCPC), established by the Associate Director for Natural Resources in April, and to a group of outside reviewers representing major fields of global change science.

The NPS GCPC and the outside experts evaluated the written proposals and oral presentations with respect to the following criteria:

1) Potential resource sensitivity to global change; 2) Availability of relevant basic data; 3) Scope of the existing science program; 4) Support capability; 5) Existence of scientific, management, and educational linkages; and 6) Relevance of proposed scope of work to both Committee on Earth Sciences (CES) priorities and objectives and NPS mission.

For each core research area, one FTE and base funding of $60,000 for operational support of a long-term global change research program will be provided shortly following the enactment of FY 1991 Congressional appropriations. Each core area will be eligible to compete on a Servicewide basis for additional global change program funds for research projects.

The GCPC recommended that NPS consolidate its focused FY 1991 Global Change Research Program in six subject areas:

- Monitoring of Potentially Sensitive Species and Ecological Communities
- Research on Potentially Sensitive Species and Ecological Communities
- Ecological Research in Small Watersheds
- Resource Ethnography
- Interdisciplinary Studies of Historical and Prehistorical Ecosystem Change
- Dynamics of Coastal Systems

The first five areas comprise a single program, "Integrated Studies of National Park Ecosystems." The program will encourage research of species, community, and landscape levels to develop a predictive understanding of the effects of global change on the ecosystems represented in NPS units and their surrounding ecological regions. The sixth area of study focuses on potential changes in the dynamics of coastal processes in response to sea level rise and the frequency and intensity of coastal storms. This thematic program builds upon the long history of NPS research on coastal barriers and other coastal areas to improve our capability to predict the effects of global change.

Each of 11 core research areas will prepare, by Sept. 1, 1990, a Global Change Operations and Conceptual Research Plan, identifying staffing, funding, logistic, and other operational requirements for the core area's long-term global change research program. This plan also will describe proposed research concepts in greater detail. The GCPC will review these plans at its next meeting in mid-October, and will recommend proposed research concepts to be developed as full proposals. The allocation of program funds is expected to be complete by May 1, 1991.

In addition to the core area programs, NPS will develop global change research initiatives based on several cross-cutting "themes." An initiative to study the dynamics of coastal barrier systems will be developed, and a symposium held. Other themes to be studied include assessing opportunities for NPS participation in research on glaciers, and the potential impacts of global change on urban national parks, with a focus on understanding the climate change effects on horticultural plants.

As a result of the New Orleans workshop, the GCPC recommended 11 research areas to the Associate Director (AD) for Natural Resources as core sites for FY 1991. Based on this review and recommendation, the AD has identified these 11 core research areas, in no priority order, for inclusion in the FY 1991 Global Change Research program: Colorado Rockies, Florida Keys, Glacier NP Area, Great Basin, Northwest Alaska, Olympic Peninsula, Ozark Highlands, Sonoran Desert, Southern Blue Ridge, Southern and Central Sierra Nevada, and Western Lake Forest.

The Fall issue of *Park Science* wil include a tear-out supplement concerning the global change program.

GIS Thesis Provides Insights

Editor's Note: As part of the requirements for his Master's Degree in Landscape Architecture from the University of Washington, Dirk Wascher studied the role and function of GIS technology in NPS natural resource management. Harvey Fleet of the ***NPS Geographic Information Systems Division*** *reviewed the thesis and culled the following highlights:*

The study's objectives were to discover technical and institutional issues regarding implementation of GIS in the NPS and to learn about NPS expectations of GIS use and Park Service philosophy, thinking, and attitude toward use of the technology. To obtain data on these topics, 21 NPS units were interviewed by telephone in April of 1989. The findings were:

(1) The start of a system frequently is accompanied by management frustrations with its complexity. User-friendlier software, particularly for vector operations, needs to be implemented. Despite this shortcoming, overall acceptance of the hardware and software is high. (2) The largest handicap for successful GIS implementation appears to be the common lack of time to dedicate to GIS activities. Adequate staff training and funding also are frequently lacking. Suggested institutional improvements include cooperation with other agencies and the GIS Division in Denver, and improvements in communication among all NPS GIS users. (3) GIS technology has vastly improved the capability of most parks to conduct, maintain, and manipulate resource inventories. The technology will very likely help parks move toward their short- and long-term resource management goals. (4) Half of all GIS users reported that they had discovered new management concepts and strategies while working with the technology.

The findings led to formulation of 17 recommendations that delineate vital aspects of technical devices, suggestions for proper choice of software applications, suggestions for training and cooperation, alternatives for internal organization, ways of extending communication, the significance of financial support, optimal definitions for management projects, and the future role of GIS for the research disciplines in the parks. The overall conclusion emerges that GIS technology provides significant enhancement of parks' capabilities to conduct, manage, and manipulate data inventories, which, in turn, can lead to more effective resource management. These advantages clearly outweigh any drawbacks that stem from the various technical and institutional deficiencies.

In addition to the direct technical enhancement of day-to-day traditional resource management tasks, GIS technology can induce more sophisticated and interdisciplinary resource management strategies; lead to a redefinition of the role of research and science in the parks; and result in new approaches toward the enhancement of interagency cooperation. The NPS eventually could serve as an intriguing model for other land management agencies. The far-sighted use of the technology can be an important contribution toward overcoming the limitations of territorial jurisdictions in the management of natural resources.

If Mr. Wascher's findings have not been prophetic, they have been insightful. In the year or so since his study, the NPS is moving forward in many of the areas he identified. The technology is being accepted ever more widely as proof of its effectiveness grows. Staffing, funding, and other institutional issues, such as cooperative mechanisms and support arrangements, continue to be problematic, but proposals for dealing with them have emerged for discussion, particularly in relation to the 1992 budget. In time, I believe we will see the realization or resolution of virtually all of Mr. Wascher's findings.

The full text of Wascher's thesis, *The Role and Function of the Geographic Information System for the Management of Natural Resources in the National Park Service,* (178 pp) may be obtained from me, NPS GIS Division, PO Box 25287, Denver, CO 80225; (303) 969-2593.

Wascher received his MA in Landscape Architecture from U/WA in June 1989, and currently is working in a nature preservation agency in West Germany.

Global Change

(Continued from page 10)

The concept of sustainable development was explored as a means of managing our global environment. Simply stated, sustainable development is management of resources to meet a society's current needs (at some reasonable level of life quality) without compromising the resources of future people. Some short term environmental degradation may occur while a given society reaches that minimum standard of living before we (citizens of the richest country on earth) can expect full international cooperation in planning global environmental management strategies. In the short term, however, we can set a better example in the US. show leadership in helping other countries achieve sustainable development, and share research and technology with developing countries.

Dr. Thomas E. Lovejoy, Assistant Secretary for External Affairs of the Smithsonian Institute, chairman of the US MAB Program, and a member of both the President's Executive Committee of the International Council of Scientific Unions and the Scientific Committee on Problems of the Environment, spoke last. He summarized current international efforts to detect and predict impacts of global change on biological diversity and then discussed why such efforts seemed only a token gesture on the part of past Administrations, the scientific community, and society. Why aren't we fully controlling CFC production? Why do we purchase products packaged in excessive, non-biodgradable containers? Why is the scientific community so fearful of taking a pro-active stance on environmental issues?

Dr. Lovejoy's presentation was delivered in a humble, almost depression-laden tone. He touched upon several of the preceding speakers' topics, concluding that "we don't know very much, we're doing very little with what we do know, and it's time to get angry."

The two-day symposium ended. The crowd left the auditorium. The speakers left Davis, presumably to speak at other symposia or to go home and carry on their important work. I left feeling more informed, more inspired to champion the cause. Perhaps it was because I was starting to get angry.

SER Conference Inspires Letter

"If not us, who? And if not now, when?"

Tony Gross, Park Ranger at Sequoia and Kings Canyon NPs, included this implicit apology for his unsolicited report on the Second Annual Conference of the ***Society for Ecological Restoration,*** *held April 29-May 3 in Chicago. No apology needed. Excerpts from his excellent report follow:*

An Aldo Leopoldian tone was set for the conference with an informal bratwurst and beer reception at the *Fermilab.* There, the impact that one person can have toward restoration is embodied in the work of Dr. Robert Betz. Betz, a physicist and a restoration visionary, led a group of volunteers in restoring farmlands and construction sites. Their work continues and they hope to reintroduce the native animal component to this magnificent restored prairie.

A synergistic effect was felt as the conference took on a life of its own – a spirit of excitement and a sense of the urgency of the mission of restoration ecologists. Jacob Sigg of the California Native Plant Society urged restorationists' involvement when he addressed the President's plan to plant 100 million trees in the next 10 years. (Without such involvement, we might have eucalyptus planted in Dr. Betz's prairie, creating a biological wasteland.)

Five symposia were presented: Recovery and Restoration of Endangered Species; Prairie Restoration: The State of the Art; Restoration, Mitigation and the Sistine Ceiling Debate; Setting Standards for Monitoring in Tallgrass Prairie Restoration; Global Climate Change – the Implications for Restoration Ecology. The theories and philosophies expounded were supported with documentation and case studies. The conference participants were not only visionaries and thinkers, they were the dirt-under-the-fingernails workers of an undeclared Leopoldian Society.

A surprising group of "doers" emerged – the US Army! Dr. Ray Hinchman of the Argonne National Lab put together an extensive program depicting the US Army's role in restoring training sites throughout the world to native vegetation.

Dr. Tom Bonnicksen's "Hi Tech" computer graphics presentation was a show stealer: a backward look in time (1987 to 1857) into a Sequoia grove at Sequoia NP. For restorationists a potentially valuable tool to describing "pristine" or any other "target-time" has emerged.

With almost evangelical fervor, soft-spoken Dr. Vine Deloria, a native American, spoke of how an effective restoration ecologist must "read the land," must "sense the spirit" of the land. Romantic notions of American Indians must give way to a close look at how they treated the land and worked with nature. Compared to European man's 500 years here, the Indian managed the land successfully for over 2,000 years. Pause to wonder!

The capstone presentation of what one individual can do was given by Dr. David Wingate of Bermuda. During his life's work of over 50 years, he and his family not only snatched the Bermuda petrel back from extinction, but restored to a "natural" state Nonesuch Island, his family's home.

SER members from all over the world participated in Chicago and will continue to encourage the grass (and trees and shrubs) to grow under their feet as they return to their own habitats with the seeds of inspiration and new techniques gleaned from this conference. Convinced that one man can indeed make a difference and that together we can leave a legacy of biodiversified natural wonders, the Restoration Ecologists reaffirmed their Partnership with Nature.

The 1991 SER Conference will be May 19-23 in Orlando, FL. Contact, SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

What is Science?

By Stephen D. Veirs, Jr.

Sometimes, we think scientists do science and other folks, including resource managers, do not. Most of us do science in informal ways all the time. The gap, if any, between resource managers and researchers shouldn't exist. Some of us have more skills than others. Some of us do more actual research than others. Some of us do research but we call it management study.

What is science?[1] Science is an informal and formal system of discovery based upon communication, logic, rules of experimentation and so on. Scientific discoveries, new theories, and experimental results are meant to be communicated, exposed to the light of critical examination, repeated, refuted, massaged and fed back into the system. By exposing methods and results, the system builds an improved understanding of the natural world. There is no sleight of hand, no magic. There may be competition and other human vices among scientists, but also there is and has to be review and professional criticism, because science requires independent verification, not just authoritative pronouncements. The recent topic of "fusion in a test tube"[2] is an excellent example of how verification and criticism work in science.

The scientific method is similar to the way most of us, more or less well, comprehend our world. We observe regular events in the world around us. We test them by experience. If they hold up we come to rely upon them as facts of life. Day follows night. Summer follows winter. Water flows downhill, becomes a solid when cooled, and so on.

As we become more sophisticated or curious, we may wonder how these wonderful things happen. What rules guide the events we observe? Can we predict future events based on our knowledge? Here I want to tell you what science is, and is not. I want to give you some examples to show you what bad science or non science might be. I want you to be sure that even though you might not be a research scientist, there are things that you can do and should do in your work to make it better. I also want to tell you what science can't do for you.

First, it is essential that you know clearly what you want to understand about your resources. You must ask very specific questions of your surroundings if you want answers that will permit you to manage them. To predict future events or effects you must have a clear understanding of the relationships of facts and the laws or theories which describe the way the facts of observations are strung together.

Much of the science done in the parks from long ago to the present has been descriptive – gathering facts, making geologic maps, mapping vegetation, taking photographs. Gathering facts, making observations, is the essential first step in understanding our park resources. Assembling the observations in some sort of order is the beginning of understanding their relationships. Based upon our perception of this information we may begin to draw inferences about how the organisms, the physical setting and natural processes work to produce the landscape we see before us. Thus we begin to construct our own theories describing these relationships whether in our work or in formal scientific study.

The observations we make in everyday life as well as the more systematic observations of science reveal certain repetitions or regularities in the world. The laws of science are nothing more than statements expressing these regularities as precisely as possible. Facts are particular events, and are distinguished from laws, which are universal statements. **Science begins with direct observations of single facts. When many observations are compared with one another, regularities may be discovered.[3] These regularities are expressed by statements of theory.** Scientific theories are regularly proposed to explain observed phenomena. Before they can become accepted explanations, part of scientific knowledge, they must prove their worth. Until then they are merely hypotheses and as the history of science shows, even highly plausible hypotheses all too frequently turn out to be false. What is the method by which they are tested and found acceptable or unacceptable?

Scientific theories are tested by deducing from them consequences regarding observable states of affairs and comparing these consequences with the results of observation and experiment. Hypotheses are tested by appropriate tests that have a high probability of a positive outcome if the hypothesis is true and a high probability of a negative outcome if the hypothesis is false. A hypothesis is either accepted because it has passed an appropriate test or rejected because it has not. Statistical methods are widely employed today as a part of the procedures by which we accept or reject hypotheses. The science of statistics has developed over the last hundred years and is increasingly used in formal scientific studies.

Unhappily, it is not possible to arrive at a complete verification or confirmation of a law or theory even after much testing of hypotheses. There is, however, a simple way laws or theories can be falsified or found untrue. We need only to find a counter instance. It is, of course, important that we be sure the counter instance is certain in itself, that we have not made an error. It is easy to refute a law, but it is exceedingly hard to find strong confirmation. The theories of evolution have been tested many times over with confirming results. Is evolution proven? No, but it is the best theory we have explaining observed changes in populations of living organisms. The recent assault by creationists on the teaching of evolution in science classes was facilitated in part by the rules of science. Evolution is an accepted scientific theory, not a provable fact, but well supported by the great preponderance of biological evidence. Other theories of why things are as they are have been set forth, but these are only weakly supported by facts and their contradictions have excluded them from serious scientific consideration. Scientists accept this ambiguity as they look to refine the "theory", but creationists use scientific skepticism as an opportunity to establish their views as a co-equal "scientific theory".

In the physical sciences, the greater ease of experimental testing tends to make confirmation of theories easier, yielding "laws" as we come to know them in the classroom – the gas laws, the law of gravitational attraction, and the periodic table are examples. Those of you dealing with biological systems must realize by now that it's much harder to come by a good biological law. The term "theory" will more often be used to describe regularities of nature as pertains to living organisms and ecosystems. By now you know that a research scientist can prove a theory wrong, but can never prove it right. As a manager you should be careful about asking them to do the impossible.

Teleology is any explanation of a phenomenon that attributes purpose to a biological behavior or function and refers to motive rather than cause. If it is said that a butterfly mimics a more aggressive organism for the purpose of protecting itself from predators, we must clarify the issue. If it is said that this mimicry is for some purpose inherent in the design of the universe, then clearly we are unable to test the explanation empirically. If we can translate the idea into a non-teleological or non-purposeful statement that deals with the evolution of a trait in relation to differential survival of the individual butterfly and the perpetuation of the species, then we may be able to sort out some tests of the explanation. Green plants will grow toward a strong source of light. Not because they "need" the light (they do) but because of biological mechanisms that we have come to understand from experiment. Cell elongation depends on chemicals produced in the stem tip. Light degrades those chemicals. The side of the stem exposed to strong light grows more slowly than the shaded side and soon the plant is growing toward the light source as all sides of the stem are evenly illuminated. You should avoid seeking "purpose" as an explanation of a natural process.

I can tell the Superintendent at Redwood something about the frequency and effects of fires in his forests. I can tell him "why" in the sense of how and when fires are ignited and spread, but not "why," in some cosmic sense, that the fires occur. Natural fires do not have a purpose. They are neither good nor bad. Their effects are just the "natural" consequences of the fire, the weather, the biological setting and so forth. Any individual may assign a value judgment to the results of a fire, depending upon his frame of reference. A forester seeking to maximize yield of sawtimber views a fire as bad. In the strict sense of managing the natural resources of a park, a naturally ignited fire in a natural ecosystem is neither good nor bad. It is just a part of the natural system.

Many of you have done or will do research, or management studies. If you do a study upon which you base some management action and it is a badly designed study, you may find your management decision reversed in court or in the courtroom of public opinion because of faulty methods, faulty interpretation of the results, poor logic, etc. You may be embarrassed. You may have wasted money. We all need to be sure what question we are asking. If we begin making predictions based on formal or informal hypotheses or theories, we may wish to test our theory by some form of test or experiment. Here are some steps to follow:

1. **Carefully define the question;**
2. **Review what is known about the matter;**
3. **Consider how you will perform your experiment;**
4. **Write up the experimental procedure;**
5. **Have it reviewed by a reliable critic;**
6. **Revise as appropriate, and determine that you are still asking the right question;**
7. **Perform the experiment, accept or reject your hypothesis;**
8. **Assess the implications of the result for your management.**

Remember that even if your hypothesis is accepted this time, it does not prove that the hypothesis is true. Your theory may fail in its next test. Or your interpretation of the results may be inappropriate. Just because there is good correlation between some observations does not mean that there is a causal relationship. Fish are always found in water. Just because we find a body of water doesn't mean we will find fish.

Is science real? Scientific realism is the position that scientific theory construction aims to give us a literally

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Rocky Mountain

Canyonlands and Arches NPs have been experiencing drought for the last two years. Data gathered through the parks' ongoing I&M program document declines in vascular plant cover and frequency (total cover, shrub cover, grass cover, and forb cover) last year, as well as a decline in small mammal populations. This year a further dramatic decline in both vegetative cover (all categories) and small mammal populations has been accompanied by a severe drop in raptor nesting success. Numbers of individuals and species of migratory birds have dropped as well.

* * *

Science in Glacier National Park, 1989 is a handsome 52-page publication, edited by Kathy Dimont of Glacier's science staff, that summarizes research projects conducted in the park. The booklet is produced by the Glacier Natural History Assn., printed by *Hungry Horse News* of Columbia Falls, MT, and is a $4 sales item at all park visitor centers. Introductory material from Supt. Gil Lusk, Chief Scientist Cliff Martinka, Ecosystem Coordinator Brace Hayden, Chief Naturalist Cynthia Nielsen, and Bob Andrews, Chief Ranger, deals with the role of science in park management, ecosystem management, and the symbiotic relationship between science and interpretation. Martinka's contribution ("Science and the Park Management Model,") opens with this quote from Lewis Thomas:

"You either have science or you don't, and if you have it you are obliged to accept the surprising and disturbing pieces of information, even the overwhelming and upheaving ones, along with the neat and promptly useful ones. It is like that."

What Is Science?

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true story of what the world is like. The acceptance of a theory involves the belief that it is true, even though scientific progress is attained by proving theories false and then moving on to construct another. Bas van Fraassen[4] makes the point that science is a biological phenomenon, an activity by one kind of organism (we humans) which facilitates its interaction with the environment. He continues, "The Darwinist says: do not ask why the mouse runs from its enemy. Species which do not cope with their natural enemies no longer exist. That is why there are only ones who do." van Fraassen[5] claims that "the success of current scientific theories is no miracle. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive – the ones which have *in fact* latched onto actual regularities in nature.

Veirs is Leader of the NPS Coop. Park Studies Unit at U/Cal Davis. This paper was presented at a Western Region Resource Management Workshop in 1989.

[1] *Throughout this presentation I have liberally used ideas and words from a collection of papers on the Philosophy of Science, in the book* Scientific Knowledge – Basic Issues in the Philosophy of Science *by Janet A. Kourany, Wadsworth Publishing Company, Belmont, CA 1987.*

[2] *Pool, Robert, 1989. Research News,* Science *243:1661-1662.*

[3] *Carnap, R. 1987. The confirmation of laws and theories, pp. 122-138.* In *Kourany, J. (see 1.).*

[4] *Ibid p. 343.*

[5] *Ibid p. 358.*

NPS and the USFWS have just released *Wolves for Yellowstone? - A Report to the U.S. Congress.* The 586-page report was produced in response to questions asked by Congress related to proposals to reintroduce wolves to Yellowstone. The report may be bought for $16.30, postage paid, from the Yellowstone Assn., PO Box 117, Yellowstone NP, WY 82190. Executive summaries (Vol. 1, 44 pp) are available for $4.20 from the same source. An 11-page digest, *Yellowstone Wolf Questions,* is available on request from Yellowstone NP Superintendent, PO Box 168, Yellowstone NP, WY 82190 or from USFWS, Federal Bldg., US Courthouse, 301 S. Park, PO Box 10023, Helena, MT 59626.



You mean it's a book about us? (Photo by Monty Sloan, Wolf Park)

At Devils Tower National Monument, researchers Fred Lindzey and Evelyn Merril from U/WY will be conducting a three year study on deer movement and habitat ecology, beginning June 1990. Twenty deer will be radio collared and extensive habitat analysis of the area undertaken in response to the game-proof fence construction on private land along the west, north, and east boundaries of the park.

* * *

Increasing threats to the quality and flow characteristics of the Gunnison River are being examined by the NPS Water Resources Branch, assisted by Monument personnel. Field studies aim at data collection and quantification, with expectation that results will be considered by the court in adjudicating the Monument's decreed water rights. The outcome of these studies may have far-reaching implications for other NPS units.

* * *

NPS has been cooperating with the Colorado Division of Wildlife (CDOW) in the removal of exotic sheep and goats from Black Canyon. Mouflon, Ibex, and feral goats have been seen there in association with reintroduced Robky Mountain Bighorn Sheep. Mouflin sheep are known to interbreed with Bighorn, and all the exotics can carry disease. To protect the health and habitat of the Bighorn herd, CDOW is conducting helicopter overflights to eliminate the exotics. Since fall 1989, 11 feral goats have been eradicated by CDOW.

* * *

CDOW is continuing Peregrine studies in the region including Black Canyon. In addition, a seasonal biological aid has been hired jointly between Curecanti NRA and Black Canyon of the Gunnison NM to provide more extensive study on Peregrine habitat within the two areas. To date, 3 Peregrines within Black Canyon have been observed. One pair has been seen defending its territory against a lone, immature female Peregrine, possibly hatched here last season. We will be looking for additional eyries this summer.

Great Smoky Mountains NP in the Southeast region has become the latest area to participate in red wolf recovery efforts. Studies have been initiated to determine habitat suitability and effects of competition with coyotes. At the same time, Superintendent Randy Pope and his staff are meeting with state agencies and local interest groups to provide information on the proposed reestablishment and allay public misgivings about once again having wolves as neighbors. If all goes well, a few wolves could be experimentally released in the Great Smokies in the spring of 1991.

* * *

Steve Cheney, Science and Resource Management Chief at Mammoth Cave NP in Kentucky, has been named Chief, Resource Management Branch, Rocky Mountain Regional Office's Division of Science and Natural Resources, beginning July 15. Prior to Mammoth Cave, he was resource management specialist at Buffalo National River in Arkansas.

* * *

Black Canyon of the Gunnison National Monument is currently addressing four areas of resource management concern: (1) water quality and water rights, (2) exotic sheep and goat impacts on Bighorn Sheep, (3) Peregrine falcon nesting activities, and (4) grazing activities and impacts.

Pacific Northwest

From John Dalle-Molle at North Cascades NP comes a two-page compendium of information about bear resistant methods of protecting food and garbage. The subjects covered are garbage containers, incinerators, food storage, and methods for warning, deterring, and aversive conditioning of bears. For more information contact Dalle-Molle at North Cascades NP, Marblemount, WA 98267; (206) 873-4590.

Dalle-Molle also put in a good word for the North American Bear Society, notice of whose new publication is contained in Information Crossfile (this issue). "They have raised considerable money to help agencies with projects such as bearproof garbage cans and providing bear information to the public," writes Dalle-Molle, who says he learned of the organization from Al LeCount, a bear biologist with AZ Fish and Game and currently president of the International Assoc. of Bear Research and Management.

* * *

"Influences of Adjacent Forest Management Activities on Migratory Elk of Mount Rainier NP" is the title of a new publication from the NPS/CPSU at OR/St/U. Authors Ed Starkey and Kurt Jenkins investigated the reasons for increased elk population in the northeastern portion of Mount Rainier NP as they related to past and future influences of forest management activities. They concluded that, although rapid liquidation of old-growth forests improved forage conditions for elk temporarily, secondary forest succession resulting from harvest has now diminished forage supplies widely and forage values are expected to decline further until regenerating second-growth Douglas-fir stands again reach harvestable age in the early 21st century. Also, they noted, elimination of mature forests used by elk during severe winters may result in elk mortality that would limit population numbers to below carrying capacity.

For copies of the 70-page report, contact the CPSU, Oregon State Univ., Peavy Hall, Corvallis, OR 97331.

Pacific Northwest *(Continued)*

A new center for research and educational activities associated with natural resource management systems that integrate production of commodities with protection of ecological values . . . this is the ambitious concept for the Olympic Natural Resources Center (ONRC), proposed by the University of Washington for the western Olympic Peninsula, with logistical support facilities that will cost about $4 million.

In addition to assisting resource managers in designing and scientifically evaluating new management practices and providing academic and continuing education programs, the center will seek to facilitate discussions among all interest groups regarding policy trade-offs involved in particular natural resource management problems. The National Park Service will be a cooperator in this project. Cat Hawkins, Natural Resource Management Specialist at Olympic NP is serving as liaison.

North Atlantic

A three-year study to determine the population levels, distribution, and movement of white-tailed deer in and around Gettysburg National Military Park has been completed by research scientists from the School of Forest Resources and the Cooperative Fish and Wildlife Research Unit at PA/St/U. This study was undertaken because of the park's concern with damage to historic woodlands from excessive browsing, the increasing losses to area farm crops, and the high incidence of deer-vehicle collisions on local roads. Copies of the 500-page report are available only from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. A 15-page executive summary is available from Acting Supt. Deckert, Gettysburg NMP, Gettysburg, PA 17325.

Dr. Gerald Wright of the NPS/CPSU at U/ID is also developing a draft Environmental Impact Assessment for the park that will describe and evaluate alternative actions for controlling the deer population. These include live-trapping and transplanting, use of fertility-control drugs, repellents, fencing, alternating agricultural crops, and no action.

* * *

The USFWS presented its regional conservation award to Cape Cod National Seashore and Gateway NRA for their work on recovery of the piping plover *(Charadrius melodus)*, a federally-listed threatened species. USFWS Regional Director Ronald Lambertson presented the awards in ceremonies at Cape Cod on Apr. 18 and at Gateway on Apr. 24, 1990.

* * *

Dr. Mary Foley has been named Regional Chief Scientist for the North Atlantic Region. Foley has worked as a forest ecologist in the Region since 1979.

* * *

The report on the white-tailed deer workshop held last year in Atlanta has been completed. Edited by Michael Soukup, Nora Mitchell, and Alan O'Connell, "White-tailed Deer in Eastern National Parks – A Management Perspective" will be published in the NPS Technical and Natural Resource Report Series and will be available in September from Donna O'Leary, Natural Resources Division, PO Box 25287, Denver, CO 80225.

Western Region

Three recent reports, obtainable from CPSU leader Denny Fenn at U/AZ, Tucson, are:

1) Rice, Carol. 1989. Live Fuel Moisture Sampling Methods for Chiricahua Ntl Mnmt. CPSU Tech. Report #27. 28pp.

2) Tamarisk Control in Southwestern United States: Proceedings of Tamarisk Conf. U/AZ, Sept. 2 and 3, 1987. Tech. Coordinators: Kunzmann, Michael R., R. Roy Johnson, and Peter S. Bennett. 1989.

3) Felger, Richard. 1990. Non-Native Plants of Organ Pipe Cactus Ntl Mnmt., AZ. CPSU Tech. Report #31. 93 pp.

* * *

Charles van Riper III (Northern UA/U) recently co-authored two peer-reviewed articles for journal publication:

1) Kern, Michael D., Mark K. Sogge, and Charles van Rkper III. 1989. Water Vapor Pressure in Newsts of the San Miguel Island Song Sparrow. Submitted to Condor. 17 p.

2) Sogge, Mark K., Chjarles van Riper III, and Charles Drost. 1989. Design Considerations for Monitoring Land Birds in Channel Islands NP. 1989 Transactions of the Western Section of the Wildlife Society. 7 p.

* * *

A May workshop at Sequoia/Kings Canyon (SEKI) included NPS cave management expert Ron Kirbo of Carlsbad Cavern, to evaluate options for managing a major, newly discovered cave in the drainage of the Kaweah River in Sequoia NP.

* * *

David Parsons, together with Norm Christensen of Duke University, has organized a special symposium titled "Climate, Fire and Forests: Understanding Vegetation Dynamics of Western Conifer Forests," to be presented at the July 30-Aug. 2 Ecological Society of America meetings in Snowbird, UT. Talks will be presented by leading scientists in the fields of climate reconstruction, paleoecology, and forest dynamics.

* * *

Vegetation and Floristics of Pinnacles National Monument is the title of a 113-page publication, Tech. Report No. 34 from the CPSU at U/Cal Davis. Authors William Halverson and Ronilee Clark surveyed 87 seits for physical features of habitat and the composition and structure of vegetatoin, describe 13 plant communities, and analyze the amount of ground disturbance caused by pig rooting. (The California buckeye woodland (67%) and blue oak woodland (39%) were the most disturbed.)

* * *

The Hawaii Environmental Education Assn. (HEEA), to foster increased effectiveness of EE in Hawaii, has elected officers, is incorporating and applying for non-profit status. Chief Interpreter Kim Sikoryak (HALE) and Research Scientist Chuck Stone (HAVO) are Directors; Stone is President. A catalog of EE programs in the State has been prepared, and breakfast meetings to encourage networking were held on four islands in October.

Roy Johnson, Senior Research Ecologist with the CPSU at U/AZ in Tucson, was selected to participate in the Arizona Rivers Assessment and is serving on the project's Riparian Vegetation committee. Johnson met recently with 20 participants from eight state and federal agencies to discuss iparian vegetation, geology, and hydrology. The working groups began standardizing a system for inventory and monitoring of riparian ecosystems, part of a statewide effort to inventory and evaluate the significant river, stream, and riparian resources of Arizona.

This cooperative project is being undertaken by state and federal agencies in conjunction with the Governor's Task Force on Streams and Riparian Resources.

* * *

Dave Parsons, Research Scientist at Sequoia and Kings Canyon NPs, presented an invited talk titled "Horses, Helicopters, and Hi-Tech: Managing Science in Wilderness" at the Society of American Foresters conference, "Preparing to Manage Wilderness in the 21st Century," in Athens GA, April 4-6. The paper will be published in the Conference Proceedings.

* * *

The 1990 March/April issue of *American Forests* contained articles by Nathan Stephenson, David Parsons, and Top Nichols (SEKI) and by Supt. Bob Barbee (Yellowstone NP), under the heading "Replies from the Fire Gods." The articles countered many of the criticisms of NPS fire management and research leveled by Thomas Bonnicksen in an earlier article, "Fire Gods and Federal Policy," appearing in the July/August 1989 issue of *American Forests*.

Southeast Region

More than 150 researchers, resource managers, and fire management personnel attended a Fire and Environment Symposium March 20-14 at the Knoxville Hilton, chaired by Ed Buckner, U/TN Professor of Forestry. Stephen Nodvin, leader of the NPS/CPSU at U/TN, chaired the conference committee, which began its work a year and a half in advance and involved U/TN, Clemson U, the TN Div. of Forestry, USFS Tall Timbers Research Station, and NPS. Presentations covered fire ecology, fire policy, and cultural aspects of fire. Presenters and attendees were from the US, Canada, Brazil, Australia, Thailand, Portugal, Kenya, and Greece.

A *Conference Proceedings*, to be published jointly by USFS and NPS and edited by Nodvin and Thomas Waldrop, will include poster and paper presentations and the keynote address by Dr. Norman Christensen. Christensen contrasted the fire status of ecosystems across the country with special examples from Sequoia, Yellowstone, and Shenandoah NPs and the southeastern piedmont forests, and summarized by tying observations on fire ecology to present and past fire policies for the NPS, the USFS, and The Nature Conservancy.

* * *

The Southeast Region is funding a coastal mapping project, with a significant portion of the GIS work taking place at U/VA. The Dept. of Environmental Sciences there has developed extensive GIS capability, to which SERO has contributed additional equipment and resources for the coastal work.

Southeast Region *(Continued)*

The following publications in the SE Region's Research/Resource Management Series now are available through Jim Wood, NPS SE Regional Office, 75 Spring St. SW, Atlanta, GA 30303:

SER 89/04, "Exotic Plant Species Management Strategies and List of Exotic Species in Prioritized Categories for Everglades NP," by Louis D. Whiteaker and Robert F. Doren.

SER 90/01, "Evaluation of Electrofishing as a Management Technique for Restoring Brook Trout in Great Smoky Mountains NP," by Jerry L. West, Stephen E. Moore, and M. Randall Turner.

"Abstracts of the 15th Annual Scientific Research Meeting, May 25-26 1989, Great Smoky Mountains NP," compiled by Jim Wood.

* * *

With the approval of the Florida Panther Interagency Committee (FPIC), the USFWS announced in the Feb. 15, 1990 *Federal Register* their intent to prepare an environmental assessment on the proposed capture of Florida panthers for captive breeding purposes. This was the culmination of a series of technical meetings and workshops held in 1989 and 1990 to address recovery efforts for the panther. Recommendations for a captive breeding program were formalized in the Species Survival Plan prepared for the FPIC by the Captive Breeding Specialist Group of the IUCN.

The *Federal Register* notice stimulated an unanticipated level of negative responses from the public, especially from certain animal rights and environmental groups. This prompted the USFWS to schedule a series of public meetings in Florida in July to present additional information on panther sttus and the captive breeding program in an effort to increase public understanding and acceptance of recovery efforts. Southeast Regional Chief Scientist Dominic Dottavio will represent NPS at the meetings.

An article by Dennis Jordan, Florida Panther Coordinator, Florida Cooperative Fish and Wildlife Research Unit, will appear in the Fall issue of *Park Science*.

Midwest Region

Butterfly Biodiversity is the title of an Isle Royale brochure designed to acquaint visitors with the ecological importance of insects and to familiarize them with Isle Royale's butterly populations. It describes how butterflies serve as "environmental barometers," and includes sketches of several species plus an observer's checklist. Bruce Weber, Isle Royale's Interpretive Specialist, calls the brochure "our attempt to help visitors focus on the diversity of wildlife other than the wolves and moose for which we're famous."

Weber will be happy to send copies to other parks that request it. Meanwhile, he is developing a new one-pager on "the little green plants commonly overlooked – mosses, liverworts, etc."

* * *

The 1988 Annual Science Report for the Region, now available, lists the research and monitoring projects for natural and social sciences conducted in the Region in 1988. It also lists issues that face the Region in the next five years. Reference copies are kept at the Regional office Omaha.

* * *

A 2½ year study to develop mangement recommendations for the federally endangered plant, *Lesquerelia filiformia*, has been completed by staff at Missouri Southern State College. The report discusses stragegies that will be useful in achieving long-term management goals. Reference copies are kept at the Wilson's Creek National Battlefield and the Midwest Regional office.

* * *

Apostle Islands National Lakeshore is attempting to parlay $15,000 of NPS science funds into a study of anthropogenic toxics in Lake Superior eagles. The lakeshore has proposed a challenge grant through its contacts in the Western Lake Superior Region Resource Management Cooperative. Formed through a memorandum of understanding initiated by NPS, the Cooperative is composed of seven Federal agencioes, Michigan and Wisconsin Departments of Natural Resources, and five academic institutions from Minnesota, Wisconsin, and Michigan.

* * *

Contract negotiations have been completed with Ecological Services, Urbana, IL, to carry out a feasibility study for establishing an Ozark Highlands MAB program. The study is supported by a grant from the US MAB Committee and contributions from the USFS, NPS, three State natural resource agencies in Arkansas and Missouri, and The Nature Conservancy. Study planning and coordination is being done through a steering committee made up of representatives from the above agencies and chaired by Dave Foster, Research Biologist at Ozark National Scenic Riverways. The Ozark Highlands MAB concept is based on surface and groundwater watersheds of the Buffalo River in Arkansas, the Current River in Missouri, and potential adjacent areas, representing this ecoregion.

* * *

The Midwest Region and Lincoln University, a historically black university in Jefferson City, MO, signed a cooperative research agreement on March 15. As a land grant institution, the university has an active extension and cooperative research program, an established natural resources department, and excellent plant and soil science research facilities. Under the agreement, the university will conduct a 2-year evaluation of the open-field management program at Ozark NSR. The university also will provide assistance in large prairie restorations at Wilson's Creek NB and several prairie parks, beginning next October.

Water Resources

The Water Resources Division was represented at the April 14 meeting of the American Society of Civil Engineers National Parks and Recreation Planning Committee. Marshall Flug was elected to the Control Group of the committee and assumes the position of Secretary beginning Oct. 1, 1990. The committee was formed to write a comprehensive Park and Recreation Planning Guidebook and to organize conference sessions, a mini symposium, and a specialty conference. NPS employees are invited to contribute to this effort.

* * *

Seven NP programs were represented at the annual NPS Watershed Research and Monitoring meeting hosted in Fort Collins April 3-5. Discussions revolved around the status of each area's watershed activities and plans and how the field watershed sites will be participating within and as part of other program initiatives such as the Global Change and the Inventory and Monitoring programs. The watershed program is aimed at implementing hydrologically, geologically, and ecologically sound monitoring and research to establish baseline data on the state-of-the-art long-term ecosystem health.

* * *

The WRD participated in the Yellowstone NP Northern Range meeting April 4-6 and assisted the Northern Range Riparian Review Committee in developing a proposal for an integrated riparian area research project at Yellowstone. The Division also took part in an interdiscipolinary team to review stream channel and riparian conditions along the Merced River in Yosemite NP and to develop recommendations for the Superintendent for a comprehensive restoration and management program.

* * *

The NP System Natural Resources Law and Policy Course held at Clemson during the week of April 9 afforded the WRD an opportunity to meet all 22 of the Natural Resource Management Trainees in Class V. They found the group "filled with enthusiasm" and they look forward to seeing them in Fort Collins for a full week on water issues. The Clemson-based course was an introduction to natural resource law and was coordinated for the NPS by the World Wildlife Fund/ Conservation Foundation.

The heaviest element known to science was recently discovered at the Lawrence Livermore National Laboratory. The element, tentatively named ADMINISTRATIUM, (Ad), has no protons or electrons, thus it has atomic number 0.

It does, however, have one neutron, 75 associate neutrons, 125 deputy neutrons, and 111 assistant deputy neutrons. This gives it an atomic mass of 312.

The 312 particles are held together in the nucleus by a force that involves the continuous exchange of meson-like particles called memos.

Because is has no electrons, ADMINISTRATIUM is inert. Nevertheless, it can be detected chemically, because it seems to impede every reaction in which it takes part.

According to Dr. M. Languor, one of the discoverers of the element, a very small amount of ADMINISTRATIUM made one reaction, that normally takes less than a second, take more than four days to go to completion.

ADMINISTRATIUM has a half-life of approximately three years. At the end of this time it does not actually decay. Instead, it undergoes an internal reorganization in which the associates to the neutron, deputy associates to the neutron, and assistant deputy neutrons, all exchange places.

Some studies indicate that the atomic mass actually increases after each reorganization.

Ethics of Environment and Development, edited by J. Ronald Engel and Joan Gibb Engel, is a collection of 23 essays by ethicist from 15 nations, providing a multicultural perspective on the ecological and human values at stake in the creation of an ethic of sustainable development.

How can we make ethical decisions about our environment in the face of increasingly conflicting needs and opinions? What is the precise meaning of the much discussed term "an ethic of sustainable development"?

The essayists address these questions from the differing perspectives of environmental ethics, development ethics, ecofeminism, religion, and humanistic philosophy. The result is food for constructive thought on new development paths that can satisfy human needs, while at the same time demonstrating respect for Earth's environment and its myriad life forms.

The 264-page volume (ISBN 0-8165-1183-7) is available from the University of Arizona Press, 1230 N. Park Ave., Tucson AZ 85719.

⁂

In the April issue of *Harper's*, the Forum section is titled "Only Man's Presence Can Save Nature: Toward an Understanding of the Environment." In it, Frederick Turner (Founders Professor of Arts and Humanities, U/TX, Dallas) argues:

"... the fundamental tendency of evolution from the big bang to the higher animals ... is a tendency toward greater reflexivity, greater open-endedness, greater complexity, and greater 'encephalization' – that is, a larger proportion of nervous tissue. Evolution in preliving chemical systems occurs slowly and has no way of changing itself. Sexually reproducing life can record itself and then reshuffle and recombine the recordings. It can improve itself; that is evolution. Then you have organisms that thrive in societies, which is just another, perhaps more sophisticated, way of passing on information to another generation. Nature has had this tendency toward increasingly more complex ways of passing on information from the big bang all the way up. Humankind is what nature has been trying, all these millenia, 'to be'."

⁂

In the same April *Harper's* Forum, Daniel B. Botkin (professor of biology and environmental studies at U/Cal Santa Barbara and author of *Discordant Harmonies: A New Ecology for the Twenty-first Century)* observed:

"As long as we thought nature was 'one state,' we didn't need to monitor it. Now that we know that nature is always changing, we must track its conditions. We need global-research institutes – one research center per continent – to study the atmosphere and the dynamics of Earth. I would revise the national park system so that the parks were connected in such a way that natural migrations might occur. As a symbolic action, I would honor the treaty with the Sioux, return the Black Hills to them to run buffalo and manage the ecology..."

⁂

The concept of a sustainable society, so prominent in Earth Week celebrations all over the world in April, was a major theme of Fritjof Capra in an address covered by *The Oregonian* in a March 8 report. "What sustainability means is keeping the long-term future in mind," Capra said. In describing such problems as poverty, development, and environmental degradation, "the only solutions acceptable," he said, "are sustainable solutions that will not create new problems of equal magnitude." Capra, who teaches at U/Cal Berkeley and researches theoretical high-energy physics at the Lawrence Berkeley Lab, calls himself a "systems theorist." "It involves," he said, "an interdisciplinary study of the relationships of all kinds of living systems...individual organisms, social systems, and ecosystems."

The National Academy of Science panel, which will review scientific research in the National Park Service, consists of the following members:

Paul Risser, Chairman; VP Research, U/NM; Durward Allen, Forestry and Natural Resources, Purdue; Ann Bartuska, SE Forest Experiment Station, USFS; John Bright, retired DSC landscape architect/regional planner; Roger Contor, retired, former NPS superintendent/regional director; Jerry Franklin, College of Forest Resources, U/WA; Thomas Heberlein, Dept. of Rural Sociology, U/WI; John Hendee, Forestry, Wildlife, and Range Sciences, U/ID; Ian McHarg, Landscape Architect and Regional Planner, U/PA; Duncan Patten, Center for Environmental Studies, AZ/St/U; Roland Wauer, retired NPS researcher and natural resources administrator; Norman Wengert, retired, public administration, CO/St/U; and Peter White, Dept. of Botany, U/NC.

The American Museum of Natural History in New York City has joined forces with two conservation and research organizations in an effort to save the world's endangered turtles, with Michael Klemens of the Museum's Department of Herpetology and Ichthyology as program director. The Museum will work with the World Conservation Union (IUCN) and Durrell Institute of Conservation and Ecology in Canterbury, England, to implement conservation projects for more than 100 species of fresh-water turtles and tortoises on 6 continents. Of the 350 species of fresh-water turtles and land tortoises, a third are in need of conservation attention. The Museum, as a research center, will bring to the project the baseline scientific data that makes both a study of dynamic ecosystems and conservation projects of this kind effective, according to Michael Novack, dean of science at the Museum. The *New York Times* Environment section carried in its March 13, 1990 edition, an extensive story of the "plight of turtles" and the Museum's efforts to reverse the decline.

⁂

Donella H. Meadows, adjunct professor of environmental and policy studies at Dartmouth College, in an article for the *Los Angeles Times* and reprinted May 15, 1990 in *The Oregonian,* described biodiversity as "the world's most valuable library: the genes of all living organisms." Biodiversity, she wrote, "contains the accumulated wisdom of nature and the key to its future." The DNA within living cells is "nature's knowledge" and as yet we have no clear idea how much of the free service performed by the earth's ecosystems will be canceled out as we crowd more and more species off the face of the planet.

Biodiversity performs services beyond price. "How would you like," Professor Meadows asks, "the job of pollinating all trillion or so apple blossoms in New York state some sunny afternoon in late May? It's conceivable, maybe, that you could invent a machine to do it, but inconceivable that the machine could work as elegantly and cheaply as the honey bee, much less make honey on the side.

"And suppose," she continues, "you were assigned to turn every bit of dead organic matter, from fallen leaves to urban garbage to road kills, into nutrients that feed new life. Even if you knew how, what would it cost? A host of bacteria, molds, mites and worms do it for free."

⁂

A USFS employee, (unnamed), is reported in *Restoration & Management Notes* (Vol. 2 No. 2, p. 57) to have "brought down the house" at the San Francisco Society for Ecological Restoration Conference in 1989 when he referred to mitigationists as "biostitutes." He was warning restorationists not to allow themselves to be used, "or you'll become apologists for development."

⁂

Russell Stafford, horticultural program coordinator for The Center for Plant Conservation (125 Arborway, Jamaica Plain, MA 02130-3520), describes in the Spring 1990 issue of *Plant Conservation* the 10-year plan to bring into the National Collection the 530 threatened plant species not yet represented. A two-year matching grant from the Andrew W. Mellon Foundation will double the donation money available for this conservation work. The spring issue features Kearney's Blue-Star – its botanic history and its reintroduction in a sycamore-lined canyon in the Baboquivari Mountains of south-central Arizona.

Don Falk, executive director of The Center, notes that the Mellon matching grant offer is "like the rare flora of the United States and this blue-green planet we live on – good for a limited time only."

⁂

A report by Mercer Cross of *National Geographic*, written for AP Newsfeatures, describes the winter haze that dims the views at Grand Canyon NP and the U.S.EPA's conclusion that the haze originates mostly from the giant Navajo Generating Station – a coal-powered, 2,250-megawatt plant at Page, AZ, a dozen miles from the northern rim of the park. EPA's conclusions were based on a 1987 study by the NPS showing that 40 to 70 percent of the layered winter-time haze in the canyon is attributable to sulfate particles coming from Navajo's 775-foot smokestacks. EPA's preliminary proposal is that $300 million to $450 million worth of pollution control equipment be installed at the Navajo plant – devices that can remove 90 percent of the pollutants. In the case of Navajo, which burns as much as 24,000 tons of low-sulfur coal each day, this amounts to an estimated 200 to 265 tons of sulfur dioxide emitted daily. A federal court has extended for one year the Feb. I, 1990 deadline for EPA to decide what cleanup measures Navajo should take.

"The issue," says Bob Yuhnke, attorney for the Environmental Defense Fund, "is whether or not we can develop a stable environmental future with a growing population. We **can** handle it. It's just a question of putting policies in place but making sure we don't trash the environment while we're accommodating growth."

An Eastern Perspective on Fuels Management and Historic Structures

By Susan Bratton

In 1981, a lightning ignited fire burned through 690 hectares of scrub and marsh vegetation on Cumberland Island National Seashore. The fire destroyed an abandoned sawmill and swept towards the historic district at High Point, which contains several turn of the century structures. The size and the intensity of the 1981 South Cut fire made southeastern resource managers aware that fires of natural origin could potentially threaten historic resources and jump the boundaries between natural and historic zones within a park.

Historically, fire in southeastern parks was generally less of a threat to structures than it is today. When the land was still under cultivation, property owners living in or near plant communities subject to frequent or high intensity wildfires, either situated buildings in locations resistent to burning, or cleared fuels from around developments. In many cases, lawns, gardens, fields and pastures adjoining cabins and barns would have provided substantial fuel breaks.

Conscious and unconscious strategies of fire prevention included placement of homes in less flammable live oak and mixed hardwood forests, sweeping lawns clear of leaf litter, and frequent burning of forest understories to remove brush and "vermin". On coastal barriers, such as the Outer Banks of North Carolina, free range grazing formerly reduced fuels around buildings. Sites such as High Point on Cumberland Island had large lawns, that protected them from high intensity fires in the nearby scrub.

Since acquisition by the NPS, the land management around many historic structures has changed. Agriculture, grazing, and anthropogenic burning have ceased, and shrub or forest succession has occurred, causing fuel loadings to increase. In some cases, the site maintained as "historic landscape" around structures on the National Register incorporates much less acreage than the area historically clear of flammable vegetation and shrub succession may occur almost up to the eaves of the buildings. These problems also concern concessions, retained rights properties, and residential inholdings.

In the southeastern U.S., many of the more flammable fuel types burn naturally on relatively short rotations. Fire history studies have documented a rotation of 20 to 25 years for scrub communities on Cumberland Island, for example. Anthropogenic burning of forest understories and litter was traditionally conducted on a one to five year basis, and settlers would reburn pine stands almost as soon as enough fuels had accumulated to carry a fire. Although major conflagrations do occur on longer rotations in the southeast, historically southern farmers and fishermen had seen numerous fires burn across the woods and marshes, and managed to reduce the risk of a natural disturbance they had observed and recognized. In some western vegetation types, where fire rotations may be 100 to 300 years, settlers and developers may have been less cognizant of the long term dangers.

In general, NPS fire protection strategies have not been coordinated with historic landscape planning, nor are they included in retained rights agreements. Fuel breaks have been constructed on the "suppression model," of narrow zones of cleared vegetation, often forming abrupt boundaries with adjoining shrub or forest communities. To improve aesthetics, to conform to historic landscape practices, and to reduce fire suppression costs in case of a wildfire, fuel breaks should be redesigned. Fuel breaks may be maintained by expanding the lawn area around buildings or by returning to historic types of lawns. This type of strategy should be effective for historic structures on Cumberland Island National Seashore, for example, where plantation lawns had a live oak canopy and an open understory with a grass sward and evergreen plantings along lanes.

Reclamation of fields or gardens, or extension of these features to their historic boundaries can produce visually appropriate fuel breaks. In cases where reestablishing historic crops, such as cotton, is not feasible, another type of vegetation, such as an open grass sward, may be encouraged as a substitute vegetation type (with appropriate interpretation to the public). Fuel breaks can be situated along historic fence lines and actually used to define the boundaries of an historic site. Where fuel breaks around retained right structures (including those on the National Register) become part of lawn or field management schemes, the holders of the retained rights may be willing to continue to mow or otherwise clear the area themselves, thus saving the NPS persen time and funds. Some fuel breaks can be better cared for by park staff responsible for cultural landscape maintenance than by fire suppression crews. Extension of lawns and fields may, in some cases, require realignment of the boundaries between natural areas and historic districts, and expansion of cleared areas in "historic zones". In all circumstances, a carefully documented historic landscape study is a necessary prerequisite to fire planning.

In the east, historic cultivars or plantings rarely present a hazard. The preference for broadleaved shrubs and trees around buildings and for evergreen hedges generally does not increase fire risk. Some species, such as bamboo, may, however, grow into thickets. When trimmed back to their historic height or boundaries, such species usually do not form continuous fuels ladders. Fire managers need to recognize that fuels reduction efforts may accidentally remove or damage historical plantings of cultural significance or of importance in conserving genetic diversity. Before any vegetation removal is attempted, the positions of plantings, borders, fences and all other historic landscape features should be determined and a fuel reduction stategy chosen which protects key historic landscape elements.

In cases where original historic vegetation types or management practices cannot be easily maintained, vegetation conversion to more easily managed semi-natural types may be considered. Around historic structures, such as life saving stations, in the interdune of the Outer Banks of North Carolina, for example, scrubland might be converted to grassland, and maintained either by prescribed burning or by herbicides. This would reduce fuel loadings, and allow acess for fire management personnel and equipment. In many historic settings, the abrupt boundaries caused by standard fuel breaks could be "softened" by expanding the width of fuel breaks and integrating them into surrounding vegetation along waving or broken lines providing natural looking scrub-grassland or grassland-forest borders. The impacts of establishing more easily managed semi-natural vegetation as a buffer between natural and historic districts need further investigation.

Incorporating fire prevention and suppression strategies into historic landscape management plans will provide better and more visually pleasing fuel breaks for historic structures. Further communication between fire ecologists, natural resources managers and cultural resources managers can optimize fire prevention strategies and lessen the chances of loss of irreplaceable historic resources.

Bratton is Coordinator of the U/GA's NPS/CPSU, Athens, GA 30602.

information crossfile

A proposal currently in the process of fulfillment would result in the world's largest nature reserve – the Chang Tang Reserve in Tibet – eventually encompassing 150,000 square miles of cold, wind-swept plain populated with scores of birds, plants and animals found nowhere else on Earth. According to George Schaller, an American biologist who has explored the region and helped negotiate preliminary agreements signed in January, this almost unexplored place "survives intact" much as it was a century ago. Schaller, a leading wildlife biologist, has done pioneering studies on gorillas, pandas, snow leopards, and other endangered animals. When he returned in late January from Chang Tang (the Tibetan words for "northern plain"), Schaller brought with him an agreement with the Tibetan Environmental Protection Agency that sets aside an original area of 100,000 square miles – about the size of the state of Colorado – and outlines steps toward establishing the reserve and proposed additions in adjoining provinces that would increase it by half again. Research will be conducted with the Tibet Institute of Plateau Biology. (*Corvallis, OR Gazette-Times,* March 8, 1990)

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A new quarterly journal, *URSUS,* is being launched by the North American Bear Society, PO Box 928I, Scottsdale, AZ 85252-9846. The full color publication will feature articles by leading biologists, naturalists, and outfitters, and deal with questions such as "What effect did the Yellowstone fires have on the bear population?"

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In laboratory experiments performed on gravel retrieved from Alaska's Prince William Sound after the Exxon Valdez spill, a biodegradable surfactant containing a soap-like material secreted by *Pseudomonas aeruginosa* bacteria removed three times the amount of oil washed away by plain warm water – the method commonly used by cleanup crews there. Steven Harvey of the U.S. Army Chemical Research, Development and Engineering Center in Aberdeen, MD and his co-workers report the findings in the March 1990 *Bio/Technology.*

Wildfire at Park Boundaries: The Wildland/Urban Interface

By Ted Morlock

As the trend towards rural development continues across the U.S. into the 1990s, parks that share their boundaries with privately owned lands need to look more closely at their wildland/urban interface. The idea of having a National Park "in your backyard" is so popular that realtors and other developers often use it as a primary selling point. With each new home constructed along a park's boundary two management problems escalate. The first is the potential for a structural or powerline fire igniting nearby vegetation within the park. The second is the potential for a wildfire exiting the park and destroying a structure. These seem like opposite scenarios but in fact they share one factor – the park boundary. Thus they require a multi-faceted solution, which may involve many individuals and agencies. During the winter of 1989-90, Cape Hatteras National Seashore undertook an experimental program of boundary fuels management and public education to reduce hazard situations at the wildland/urban interface in the Buxton Woods area of Hatteras Island.

Prior to initiation of the management program, fuel and vegetation maps were prepared for Buxton Woods, the largest remaining maritime forest in North Carolina. A fire history study by Kent turner indicated ignitions at Cape Hatteras were primarily anthropogenic. Field survey data taken by Katherine Davidson and Susan Bratton indicated that Buxton Woods had burned several times within this century and that successional loblolly pine *(Pinus taeda)* stands had greater loadings of fine fuels and were more likely to burn than laurel oak *(Quercus laurifolia)* and mixed hardwood stands. In some cases, new homes had been constructed in pine stands adjoining the extensive, and moderately flammable, pine and wetland areas within the park. The simplest, and often only strategy, in such a situation is to provide a fuel break along the boundary. This may be accomplished either through mechanical manipulation and removal of fuels using chain saws and other tools, or through the use of prescribed fire.

In Buxton Woods, the volume of pine litter and the proximity of homes to the park boundary discouraged the use of fire. Further, historic vegetation analysis indicated the Woods had been dominated by live oak *(Quercus virginiana)* prior to the colonial era. Prescribed burning might inhibit desirable hardwood succession and might actually maintain more flammable pine forest types. The use of prescribed burning also was limited by authorization difficulties, public aversion to burning near their properties, and shortages of fire protection personnel (both in the planning and execution phases) and equipment. Although more time consuming and less effective than prescribed burning, mechanical manipulation was thus effected along the six-mile park boundary through the Woods.

The actual treatment consisted of removal of all underbrush (laddering fuels), trees less than 3" dbh and any dead and down fuel concentrations for a 10' width along the relatively level terrain of the boundary. Resulting slash was scattered in the park or hauled to a safe burning location, to prevent hazardous fuel buildups along the treated area. This initial treatment required 10 person days (1 pay period) and 50 hours chain saw useage per mile (using an experienced sawyer). Long-term management will require 4 person-days and 20 hours motorized brush cutter usege per mile if done annually. The resulting fuel break provides minimal protection against anything more inense than slow-moving ground fire, but greatly inreases access along the boundary for firefighting personnel and equipment. Providing high boundary discernment is a benefit with some disadvantages. It may increase use by poachers and ATVs. It may inhibit movement of some small animals. If not done carefully and with forethought it may be aesthetically repulsive and cause homeowners and park visitors to object.

In conjunction with fuels management, a complex, though potentially more effective program, was undertaken to educate and involve the neighboring community, including homeowners, local fire departments, and developers. In the eastern U.S., many homeowners are unaware of the dangers of fuels build-up and do not perceive wildfire as a threat to a second home "at the beach". Further, those that do recognize the danger do not consider it their responsibility to take preventive measures. They assume the fire departments and government agencies will suppress fires and conduct any necessary fuels reduction. The education program therefore attempted to make the public recognize that the responsibility of fire protection is not the Park Service's exclusively, and that in the event of a major wildfire, available fire protection personnel and equipment might be insufficient to save their homes. Through meetings with officials (fire chiefs, county planning board members, county fire marshalls, etc.), discussions with school authorities (to develop programs for students), and instructional handouts for homeowners, the concept of fuels management as a community responsibility began to spread in the Buxton Woods area. A fire technician personally met with homeowners to explain how they could help protect their residences, and presented training videos to the local fire department.

The fuel management program for Buxton Woods encountered a perception of forestry that clashed with contemporary fire management concepts, especially at the county planning level. Since maritime forest is a threatened habitat in North Carolina, the trend has been to push for open space areas, with limited vegetation removal. Although this type of land use planning

Continued on page 19

Effects of Severe Fire in Coastal Scrub

Although National Seashores are not usually considered to be "fire prone" parks, several east coast barrier islands have areas of high fuels. During 1987 and 1988, the University of Georgia Cooperative Studies Unit investigated the historic impact of severe fire in coastal scrub (or pocosin) and fresh water marsh communities on adjoining live oak *(Quercus virginiana)* forest on Cumberland Island National Seashore. Seven series of aerial photographs, taken between 1953 and 1988, were analyzed to determine the location of boundaries between plant community types before and after fires. A sampling team established permanent transects between scrub and forest communities, and evaluated the basal area of woody vegetation along gradients between scrub and better developed oak forest. A green house bioassay of soil fertility also was conducted.

The project found, that despite the highly flammable nature of the scrub and the history of repeated fires in the dense thickets, disturbance was not correlated to the areal extent of scrub or marsh communities. The scrub and marsh boundaries expanded, rather, in response to periods of high precipitation; thus boundary changes were related to the coastal drought cycle.

Scrub forest boundaries were relatively dynamic compared to marsh/forest boundaries. In recent years, extensive browsing by white-tailed deer has limited survival of live oak sprouts after fires. If scrub communities expand into oak forest, it will ultimately be a result of herbivore impacts, and not of high intensity fires. The data suggest wildfire plays a minor role in boundary dynamics among these communities, and that fire suppression should not be necessary to prevent loss of oak forest along the scrub boundary. Further reduction of the deer herd would, however, be very desirable.

Guy McPherson/Susan Bratton
NPS/CPSU, U/GA, Athens



***Burning slash** after fuels removal along the boundary between Cape Hatteras National Seashore and nearby developments.*

Do Parks Make Good Neighbors?

By Robert E. Manning

Many of America's national parks have become islands of nature in a sea of civilization. Development of land around and adjacent to parks has raised a variety of management issues, including air and water pollution which flow into the parks, limited range for wild animals, increasing demand for recreation opportunities, and incompatible development along park boundaries. These and related park management issues – collectively termed "external threats" – reached crisis proportions in the decade of the 1980s.

However, another side of this issue is beginning to emerge as well. Just as parks and park management can be affected by surrounding lands, so too can surrounding lands and their owners be affected by parks. Parks, wilderness and related public lands often draw thousands or even millions of visitors annually, and public ownership of land can have important implications for property taxes and other community affairs. This study was designed to explore how the presence of a national park was perceived to affect private landowners and their communities.

The study focused on Acadia NP, which is located on Mt. Desert Island, Maine. The park occupies approximately one-half of the island, the other half comprised of private lands organizaed into a number of small communities. The park boundary is highly irregular, resulting in a complex landownership pattern highlighted by substantial intermixture of public and private land. The park is heavily visited.

The principal objective of the study was to determine the effects of the park on surrounding areas as perceived by residents of Mt. Desert Island. A standard questionnaire was administered by mail to a 10 percent systematic random sample of residential property owners on the Island. Sampling was conducted using the property tax records of all communities on the Island. Respondents were asked to rate the degree to which the park positively or negatively affected 33 items related to personal and community life. A response rate of 83 percent was attained, yielding 542 completed questionnaires.

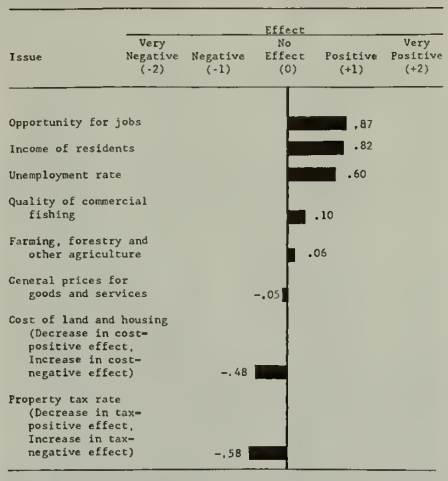


Figure 1. *Resident perceptions of the effects of Acadia NP – economic issues.*

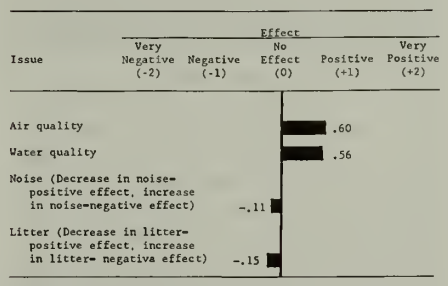


Figure 2. *Resident perceptions of the effects of Acadia NP – environmental issues.*

Study findings are summarized in Figures 1-5 which report mean responses. From the findings several conclusions may be drawn. First, respondents feel that the park does affect them in a multitude of ways. For only two of the 33 items included in the questionnaire did a majority of respondents feel the park had "no effect."

Second, it is clear that the park is perceived by residents as having both positive and negative effects. Using the mean responses shown in Figures 1-5, it can be concluded that respondents felt the park had a slightly-to-moderately negative effect for 12 of the 33 items explored. The most clearly negative items were property tax rate, cost of land and housing, and traffic congestion. Most residents apparently believe that property tax rates are abnormally high due to the presence of the park. This situation may be due to the fact that land in public ownership generates little or no property tax revenue for local governments, placing what is perceived to be an undue burden on private property owners.

Another contributing factor may be an abnormally high rate of appreciation of private land values as there is a reduced supply of private land and their market price may be bid up quite steeply. (Demand for commercial tourist development and vacation homes is spawned by the presence of the park.) Most residents also believe that the park has a negative effect on the cost of land and housing; that is, the presence of the

Continued on page 20

Wildland/Urban Interface ***(Continued from page 18)***

is derived from an interest in protecting the uniqueness of the maritime forest, it is self defeating from a fire prevention standpoint. The resources it strives to protect will be destroyed in the event of a wildfire. At Cape Hatteras a 170 unit subdivision, which is located immediately adjacent to the park boundary, is being developed under a county ordinance which prohibits removal of any vegetation beyond 30 percent of the lot area (roughly the amount necessary to build the structure, no more). The justification for this code is protection of the freshwater aquifer from excessive runoff. This same subdivision is being built under building codes which require "low visual impact", highly flammable, natural building materials. Hazard fuels were not considered when the ordinances were developed, so the design of the subdivisions considers only the impact of the new housing on the natural ecosystems and does not consider potential impact of adjoining wildlands on the housing. Future plans should consider both elements, thereby avoiding conflicts between human communities and park resource management programs.

Evaluation of the wildland/urban interface at Buxton Woods suggests that further research and managerial experimentation on maintaining fuel breaks is desirable. Use of fire resistant vegetation or vegetation conversion to low fuel plant communities, for example, are options which have rarely been employed in national parks. This approach can encourage natural succession of native fire resistant vegetation, such as live oak, or their use in landscaping applications. This may be a very valuable option around residences and park historic structures where removal of vegetation using either mechanical means or prescribed burning may be undesirable. This treatment may also be viewed, by county planning boards and other officials, as a suitable compromise in situations where runoff and watershed protection are primary considerations. Vegetation conversion or establishment of fuel breaks of adequate width to protect structures and developments exterior to the parks may, however, effect wildlife movements or habitat use. More information is needed on optimal strategies for boundary management.

Parks interested in obtaining information or training materials on the wildland/urban interface should contact: NPFA (National Fire Protection Association), Batterymarch Park, Quincy, MA 02269.

Available publications are: *Protecting Your Home From Wildfire,* a handout booklet for distribution to homeowners; *Wildland Fire Management Briefings; Wildfire Strikes Home,* Newsletter; *Wildfire Strikes Home,* Annual Report; and *People and Fire at the wildland/urban interface* (a sourcebook).

Contact; Bill Baden (wildland/urban interface specialist) 617-770-3000, ext. 7484.

Available videos are: *Wildland Fire Strikes Home,* discusses the 1985 fire season, the worst in history for the wildland/urban interface; *Wildland Fires Satellite Broadcast,* looks at the 1987 wildfire season, details ways to protect your home and methods for building interagency cooperation.

Contact: Manuscriptions, 28 South Main St., Suite 256, Randolph, MA 02368 – also available through BIFC by spring, 1990.

Morlock is a Research Technician, Institute of Ecology, University of Georgia, CPSU, Athens, GA.

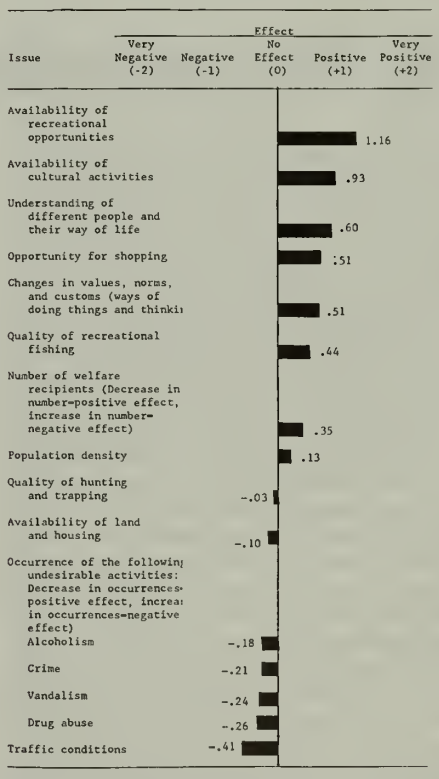


Figure 3. *Resident perceptions of the effects of Acadia NP – social and cultural issues.*

Do Parks Make Good Neighbors? *(Continued from page 19)*

park has caused land and housing costs to rise abnormally high. Finally, respondents clearly believe that the high level of visitation to the park causes traffic congestion with which local residents must contend.

The majority of items explored were perceived to be slightly-to-strongly positively affected by the park. The most clearly positive were availability of recreational and cultural opportunities, opportunities for jobs, income of residents, and fire protection. Respondents apparently recognize that the large number of visitors attracted to the park makes possible the provision of opportunities for recreation, shopping and culture which could not otherwise be supported on the Island. They also appreciate the economic benefits brought about by a large infusion of park visitors and understand that these expenditures create jobs and income in local communities. There is also an apparent belief that the presence of a major unit of the National Park System can enhance traditionally local government services such as fire and police protection.

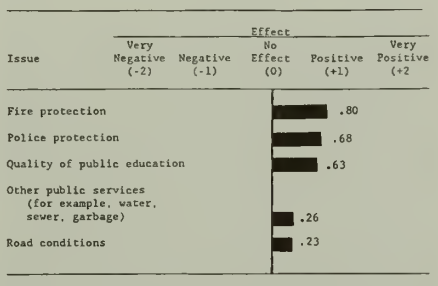


Figure 4. Resident perceptions of the effects of Acadia NP – public service issues.

Finally, a summary item, "general quality of life," was included in the questionnaire. The vast majority of respondents felt the park had an overall positive effect on their lives and on their communities.

Findings from this study indicate that, for the most part, parks can indeed be good neighbors. However, two notes of caution are in order. First, it should be emphasized that these findings relate to *perceived* effects of the park. These perceptions may or may not be related to real effects, at least for some items. Nevertheless, perceptions of local residents are important unless they can be proven wrong empirically. Second, although most items explored in the questionnaire were perceived as positively affected by the park, the attention of the park managers should be drawn to the issues perceived as negatively affected. Negative perceptions should be corrected where they are believed to be in error; action should be taken to ameliorate negative effects where possible.

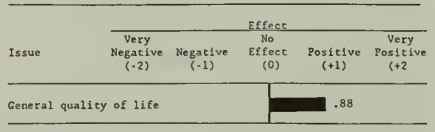


Figure 5. Resident perceptions of the effects of Acadia NP – overall quality of life.

Over the past decade it has become clear that parks are inextricably tied to lands outside their boundaries. This issue has been framed primarily in terms of the effects of these surrounding lands on park management. This study illustrates that there is another side of this issue as well. Parks are clearly perceived to affect surrounding lands. As the interconnectedness of public and private lands is more widely recognized, it will be necessary for park managers to reach out beyond the borders of their areas to deal successfully with "external threats". They are likely to be more effective in this process if they are aware and sensitive to effects they in turn have on surrounding communities.

Manning is a Professor and Chairman of the School of Natural Resources Recreation Management Program at U/VT, Burlington.

In the Next Issue

"Investigations of the Malaspina Glacier, Wrangell-St. Elias NP&P, Alaska," by Bruce Molnia and John Jones; "Peregrine Falcon Research in the Yukon-Charley Rivers National Preserve, Alaska," by Skip Ambrose and Steve Ulvi; "The Cumberland Island Cotton Mouse," by James Boone, Joshua Laerm and Michael Smith; "Great Basin National Park: A Crisis in Vegetation Management?" by Raymond Jaindl, Lee Edelman, William Brock and Boyd Eyelich; "Native Brook Trout Restoration in Great Smoky Mountains NP," by Stephen Moore and Gary Larson; "Natural Resource Management at Colonial NHP," by Chuck Rafkind; "A Sea Urchin's Response to Mass Mortalities," by Don Levitan; and "Visitor Services Project," by Dana Dolsen.

In addition, the Fall issue will include a separate section on the NPS Global Change Project plans.

Black Canyon Grazing Plan

Black Canyon's grazing management plan was implemented in 1989. Grazing was authorized in 1984 as part of the Monument's legislative expansion and land acquisition. Under the plan, the Monument administers allotments that include private, BLM, and NPS lands. Cooperative agreements were obtained so that a single plan, overseen by Monument staff, would assure a cohesive grazing operation. Current drought conditions may test the durability of the current plan and identify necessary changes.

A Superintendent Says YES!

In the early years of the National Park Service Stephen Mather dealt directly with park neighbors. Frustrated with Great Northern's procrastination at removing a "temporary" sawmill in Glacier NP, Mather assigned a trail crew to blow it up. Today, however, the world is more complicated; such "quick fix" solutions are sure to generate more problems than they solve.

Although methods may have changed, the need for interaction between parks and their neighbors has grown. All of today's park managers and employees need to expand their vision, knowledge and expertise over the boundary fence and become directly involved in the issues of nearby communities. We can better preserve our national treasures by taking a leadership role in protecting ecosystems, landscapes and waterways whether or not we own them. When we protect the region from the adverse impacts of acid rain, we protect our parks. When we help manage visitor impacts on neighboring communities, we in fact manage visitor impacts within our parks. When we recognize that parks are an integral part of the national and international tourist industry, we can better articulate why our parks are important in local and regional economies. When we emphasize that parks are educational resources, increase their use for scholarly pursuits, illuminate their historical and scientific value, then we establish the parks as unique and vital entities in the communities in which they are located.

Acadia NP is intimately linked with the communities of Mt. Desert Island. Dr. Manning's study has documented and illuminated many of these relationships. We are reassured that Acadia is perceived as a good neighbor in many ways. However, there is room for improvement. Since completion of this study we have worked in several ways to further improve our relationships with surrounding communities. A few samples include:

- Our general management plan leader has moved to the park making a long term commitment to learn and understand park issues and their implications on the region's economy and quality of life.
- The park's advisory commission (which has representation from 10 towns as well as state and federal appointees) has been directly involved in the general management plan process.
- The park participates actively in the Mount Desert Island League of Towns (comprised of the managers of the four communities on Mount Desert Island and the Superintendent of Acadia). The League has identified five problems of islandwide significance and is acting cooperatively to seek solutions. These problems include solid waste management, affordable housing, property tax relief, regional planning, and water resources.
- The park actively serves on the University of Maine Forest Resources Research Advisory Commission, which sets the agenda for the University's resource management and wildlife research programs.
- The park serves on the Eastern Maine Development Commission Tourism Advisory Council which develops recommendations on tourism management issues for eastern Maine.
- The park helped in establishment of monthly informal breakfasts with the Superintendent, President of the College of the Atlantic, Director of Jackson Laboratories, Superintendent of public schools, Coast Guard Base Commander, Director of Mount Desert Island hospital, and the four town managers.
- A number of park staff serve on selected municipal conservation and planning committees.

Based on our experiences I can report both promises and pitfalls as a result of increased interaction with surrounding communities. The effort may tax one's nervous system, strain financial and staff resources, and encourage accusations of "federal interference." However it can also add vitality and excitement to an organization's blood that some feel has grown thin. Ultimately, it is the only way to ensure preservation of Acadia NP and Mt. Desert Island as well.

Jack Hauptman, *Superintendent*
Acadia National Park

Purple Loosestrife Control In Voyageurs National Park

By Jim Benedict

Voyageurs National Park was established in 1975 to preserve the outstanding scenery, geological conditions, and waterway system which constituted part of the historic route of the voyageurs who contributed significantly to the opening of the Northwestern United States. Located in northeastern Minnesota along the international boundary with Ontario, Canada, the park is distinct from the adjacent Boundary Waters Canoe Area Wilderness (BWCAW) in that motorized recreation, (e.g. motorboating and snowmobiling) are permitted in Voyageurs but not in the BWCAW.

Resource management and research at Voyageurs NP are designed to maintain, protect and restore the integrity of the park's natural ecosystem and ecological processes. The principles and techniques of restoration ecology are being used to restore the integrity of park resources to the extent practical and feasible. Implementation of these programs would be impossible without the cooperation and support of numerous federal, state, provincial and local agencies, organized groups, and private citizens.

A survey for purple loosestrife *(Lythrum salicaria)* in the park in August 1987 and June and August 1988 revealed scattered pockets of this exotic weed along the west shoreline of Kabetogama Lake. About 60 acres of wetlands are currently affected. Most affected sites are accessible only by boat and contain populations densities from 100 to greater than 100,000 plants per acre. If we fail to control these scattered, isolated weed populations in the next few growing seasons, they could foreseeably become widespread in the park and impossible to control or limit.

Purple loosestrife is an erect, herbaceous perennial of Eurasian origin. Introduced to North America in the early 1800s, it now poses a serious threat to native emergent vegetation and associated wildlife in shallow-water marshes throughout the northeastern and northcentral states. In Minnesota, this phenomenally prolific exotic has spread to more than 800 sites. Over 20,000 acres of wetlands now are covered with loosestrife. Because of its exotic origin, it has left behind all of its natural enemies and predators and multiplies with no checks and balances in North America. Loosestrife crowds out undisturbed native wetland vegetation, such as cattails, bulrushes, reeds and sedges, that are required by fish and wildlife for food, shelter and breeding, while having little forage value itself for fish and wildlife.

A coalition of Minnesota government agencies and conservation organizations (The Purple Loosestrife Coalition, Minnesota Trappers Association, Minnesota Waterfowl Association, and Pheasants Forever) has initiated a loosestrife control program in Minnesota. In 1987, purple loosestrife was designated a noxious weed in Minnesota by the commissioner of agriculture. In 1988, the commissioner designated wand lythrum *(Lythrum virgatum)* and winged loosestrife *(Lythrum alatum)* and any combinations thereof to be noxious weeds. This action was taken because identification of *Lythrum* hybrids and cultivars is very difficult if not impossible. The noxious weed law and 1988 order prohibit the sale and transport of all these plants in Minnesota.

The Minnesota Departments of Natural Resources (MDNR) and Agriculture (MNDA) are the two lead agencies responsible for coordinating loosestrife control efforts throughout the state. Voyageurs NP has been working with these and other state and county agencies, groups, and private citizens to control park loosestrife populations and to make areawide control actions more effective. Control work and permitting for loosestrife control are being coordinated among landowners in the Kabetogama Lake area.



***Purple loosestrife control** in Voyageurs NP, MN.*

NPS Management Policy on Exotic Plants and Action Threshold

The NPS defines exotic species as those that occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans. Exotic species, such as purple loosestrife, in Voyageurs NP are of special management concern because: (1) when they invade and displace native plant and animal species they could alter park successional processes, community productivity, diversity and stability; (2) they represent deviations from natural ecosystem conditions present during the era of the voyageurs; and (3) their presence provides the visitor with a skewed impression of the park's natural vegetation and wildlife.

Management of populations of exotic plants, up to and including eradication, will be undertaken wherever such species threaten park resources or public health and when control is prudent and feasible. The presence of one individual plant growing anywhere in the park is an unacceptable risk to Voyageurs' natural resources. The threshold for control action in Voyageurs' is, therefore, the presence of one individual plant in the park.

Implementing the Control Program

Methods for eradicating large, dense populations of loosestrife are not currently available. The most effective and efficient control strategy at this time is to quarantine loosestrife to sites already severely infested by: (1) monitoring wetlands that do not currently have loosestrife to ensure that any invasion is detected early and removing any discovered seed sources; (2) eradicating small populations in wetlands that are not severely infested; and (3) removing plants around the edges of severe infestations to prevent further spread of the patch. A number of control or eradication methods have been tested: doing nothing, pulling and digging, cutting, burning, flooding, and broadcast and spot spraying with various herbicides.

Since August of 1988, we have been controlling purple loosestrife in Voyageurs by annually spot spraying individual plants of high density populations (from 10 to greater than 1000 plants per acre) twice between late June and early August with SEE-2,4-D, an aquatic herbicide which is not lethal to all wetland plants. Great care is taken to treat only the loosestrife and avoid spraying associated wetland plants, such as cattails, bulrushes, sedges, willows and alders.

To prevent regeneration, any flower stalks remaining after early August are cut and bagged, removed from the wetland, and burned. Treatment areas are posted as closed to swimming and fishing for three days after spraying. In low density populations, with young plants (less than 10 plants per acre) and localized areas where herbicide use may be restricted for public health reasons, we annually control loosestrife using non-chemical control methods, primarily pulling and digging of individual plants. Wetlands that do not currently have loosestrife are monitored to ensure that any invasion is detected early. The control program effectiveness is monitored annually.

To date, the most effective and least costly method for controlling loosestrife where the plants cannot be pulled, is with spot applications of herbicide. The aquatic herbicide SEE-2,4-D effectively kills purple loosestrife while not posing a threat to public health. SEE-2,4-D is biodegradable and very short-lived, quickly inactivated when it contacts moist soil. SEE-2,4-D is approved by the U.S. Environmental Protection Agency and the Minnesota Department of Natural Resources for use over open water, such as wetlands. Spot application allows effective use of the herbicide with little or no damage to desirable perennial plants. SEE-2,4-D is taken up through leaves or young stems and will kill any herbaceous, broadleaved plant that it contacts on these tissues. This makes it important to treat only the loosestrife and avoid damaging the desirable perennials. If this can be accomplished, most of the loosestrife will be removed and the relatively small "holes" in the vegetation will quickly fill with other perennials.

Follow-up treatment with SEE-2,4-D for at least three or four more seasons will be necessary to take care of missed plants, new seedlings that will germinate, the roots of many older plants that will survive and resprout, and seed transported to the park by wind, water and wildlife from infested areas inside and outside of the park. Some level of control action using herbicides will be required on an annual basis thereafter for the foreseeable future. If we can prevent the park's loosestrife plants from setting and dispersing any more seed, we will gradually use up all the seed stored in the soil. Over time, therefore, we should see a dramatic reduction in the areal extent of the infestation.

As the park's purple loosestrife populations develop resistance to SEE-2,4-D, another selected broadleaf herbicide approved for use in aquatic environments will be used to control loosestrife for several years. At that time, we may switch back to using SEE-2,4-D or another approved herbicide. We can hope that a biological control agent for loosestrife will be found by the

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Vegetation Restoration Planning at Lincoln Boyhood National Memorial

By Noel B. Pavlovic

Many NPS units were created in the 1960s and '70s from a mosaic of natural communities and man-produced landscapes. The 200-acre Lincoln Boyhood National Memorial (LIBO), Spencer County, Ind.,for example, was amalgamated in 1962 from a mosaic of reforested land, old fields and abandoned homesites. In 1984, I was asked by Mike Ruggiero, then Midwest Region Chief Scientist, to conduct a study of what the vegetation was like when the Thomas Lincoln family arrived there in 1816.

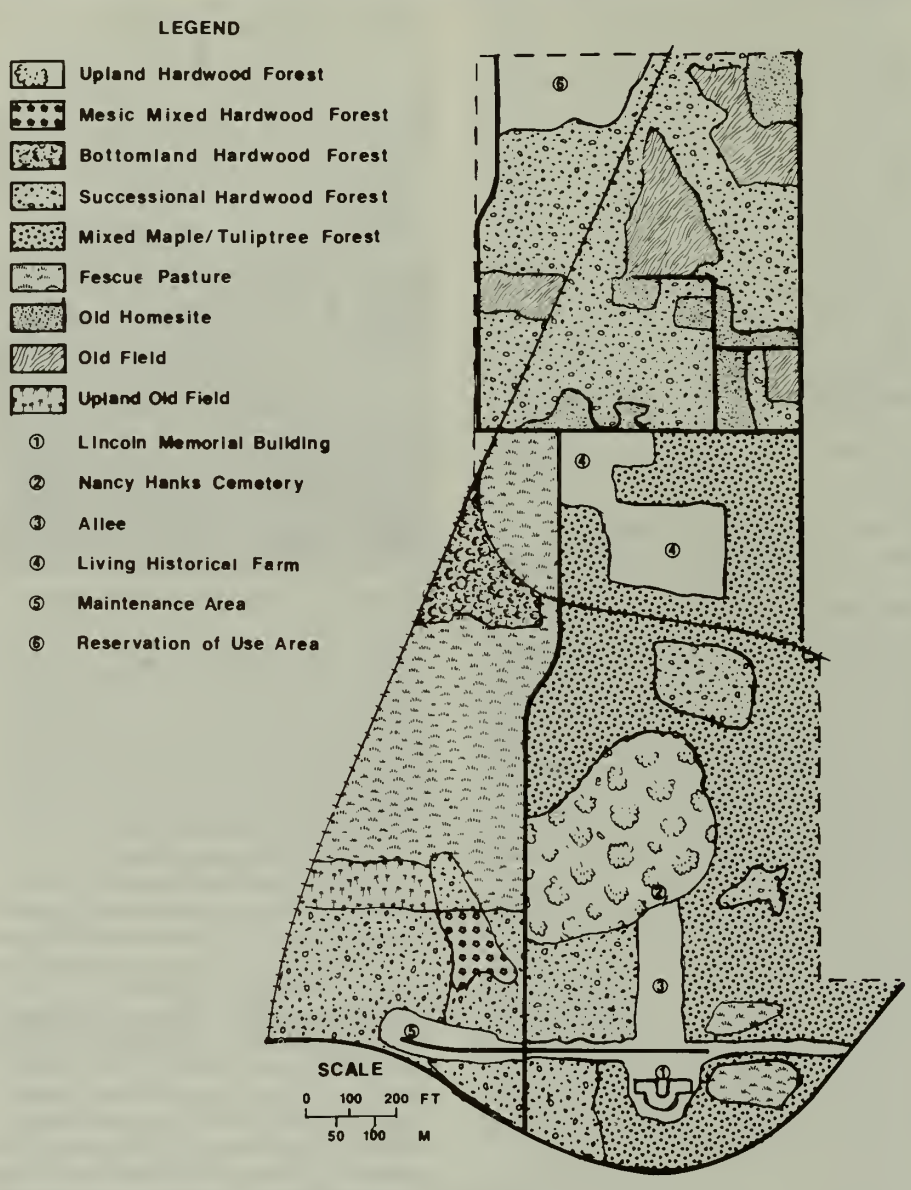
The project was motivated by the park's management goal of re-establishing the historic scene. Here Abraham Lincoln spent most of his childhood and suffered the loss of his mother, Nancy Hanks, from "milk sickness." We were to compare and contrast the 1816 vegetation with existing vegetation and recommend how the park could recreate similar community types. A ranking system was developed to assist in the prioritization of management activities. Unlike historical and cultural parks in the east, there were no records that would allow the recreation of a historically accurate landscape scene.

We used the 1805 General Land Survey Notes to examine the presettlement forest cover surrounding the land that was to become LIBO. We sampled the existing vegetation, using 52 stratified random 1/10th hectare plots throughout the park. All trees were identified and measured for diameter at breast height and shrub species were counted in a nested 1/20th hectare plot. Herbaceous frequency was quantified based on a systematic sample from 10 quadrats within each plot.

Classification Problems

Indirect gradient analysis and cluster analysis indicated a diverse type of communities bearing little relationship to topographic moisture gradient position. Consequently, the stands were classified relative to composition and past history and included bottomland and upland old fields, successional forest, upland old growth forest, mixed maple/tulip-tree forest (planted in the early 1900s) and abandoned homesites. Additional management research examined the possibility of tree planting in abandoned land and methods for eliminating Japanese honeysuckle.

Witness tree composition was examined across a topographic gradient and revealed the landscape was dominated by variants of oak-hickory forest. Based on these findings, along with soil and ecological information, Lincoln Boyhood was judged to have three types of oak-hickory forest: 1. bottomland forest, 2. mesic mixed forest, and 3. upland forest. The bottomlands and flatwoods had a mixture of pin oak, bitternut hickory, red maple, sweet gum, red elm and sycamore and river birch along stream courses. North facing drainages had a high diversity of mesic species, including white and black oak, black walnut, bitternut and shagbark hickory and white ash, with an understory of dogwood, pawpaw, and spicebush. Such diversity was probably maintained by protection from fire and moderation of droughts. Uplands were dominated with white and black oak, shagbark and pignut hickory and an occasional white ash. More exposed sites had more black oak and some individuals of post oak. The typical understory contained dogwood, redbud, and black haw.



Map of existing vegetation at Lincoln Boyhood National Memorial.

Two Remnants Survive

Sampling of the existing (1985) vegetation revealed two remnants of the presettlement vegetation. Surrounding the highest point in the park and the Nancy Hanks Lincoln cemetery is a remnant oak-hickory forest. This old growth forest retained its canopy composition and structure; however past grazing (hogs) had nearly eliminated the characteristic spring ephemeral geophytic herbs. The latter conclusion was based on the abundance of jack-in-the-pulpit and

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Purple Loosestrife *(Continued from page 21)*

time resistance becomes a concern.

Our monitoring the effectiveness of herbicide control on loosestrife and associated native wetland vegetation within the park involves permanent plots that are rephotographed each year. Photographs were taken in August 1988 prior to and after treatment and each August thereafter at Kecs Kove and Rantas Bay.

Since August of 1988, we have sprayed all loosestrife stands in the park and vicinity three times. Although the areal extent of the infestation is unchanged, we have reduced the density of plants by 95 percent in the park's wetlands. The age structure of these stands also has been altered dramatically. Instead of flowering plants that are three to six years old, the vast majority of flowering plants during the third spraying were one year old. By spraying twice a summer, until the seed source is used up, we will be able to prevent loosestrife from setting and disseminating any seed in these infested areas. As loosestrife's seedbank becomes exhausted, we should see a dramatic reduction in the areal extent of the infestation, as well.

For more detailed information about our program, a copy of the park's Purple Loosestrife Control Plan may be had by calling (218) 283-9821 or FTS 780-5466.

Benedict is a Resource Management Specialist at Voyageurs NP.

Island Horses' Genetic Diversity Evaluated

By Susan Bratton, Robin Goodloe and Robert Warren

Unlike most species of feral animals in NPS areas, free ranging horses have been considered a potential historic resource. For the barrier islands along the Atlantic coast, tales of Spanish mounts washed ashore from shipwrecks dominate the popular literature on the origins of the isolated herds. The management of island equids has long been controversial. The horses themselves are very popular with park visitors. Feral equids can, however, become campground pests or endanger people who expect them to behave like pets. The larger populations, such as that on Cumberland Island, GA, heavily utilize native marsh and inter-dune vegetation, which can encourage local soil erosion via grazing and trampling. Maintenance of "historic" horses may thus conflict with other natural resources management objectives.

In 1986 and 1987, a research team from U/GA, Athens, collected blood samples from feral horses on Cumberland Island National Seashore, and Cape Lookout National Seashore (Shackleford Banks), NC, by immobilizing adult animals with etorphine hydrochloride and xylazine hydrochloride. (Initial attempts at immobilization resulted in two deaths due to capture myopathy. This problem was corrected by administering sodium bicarbonate – physiological solution intravenously to animals while they were immobilized.) The team also collected blood from ponies on Cape Hatteras National Seashore (Ocracoke Island) and from Chincoteague National Wildlife Refuge on the southern end of Assateague Island when the animals were corralled for annual veterinary care. Samples were sent to the laboratory of Dr. E. Gus Cothran in the Department of Veterinary Science, University of Kentucky, where standard starch gel and polyacrylamide gel electrophoresis were used to assess genetic variability at 10 enzyme or protein loci. In addition, red cell alloantigens at six blood group loci were detected using standard immunological procedures. These types of analyses had already been performed for many breeds of domestic horses, so genetic resemblance between populations could be easily determined.

The study looked first at measures of genetic diversity including heterozygosity and the number of alleles per locus. All 16 loci analyzed were polymorphic in at least one of the populations, and 10 were polymorphic for all of them. The samples from Assateague Island had the greatest degree of polymorphism. The four island horse populations tended to share the same predominant or fixed allele at each locus and these, in general, corresponded to the predominant allele in domestic horses. All alleles identified had already been reported for domestic horses, implying the barrier island herds did not possess any unique genetic material found only in feral populations.

The results also provided little evidence of inbreeding. No significant deficiency in mean multilocus heterozygosity was apparent, although the mean number of alleles per locus in some feral herds was slightly lower than the mainland breeds. This, however, may have been the result of small sample sizes. The Assateague Island sample produced 74 of the 95 alleles known to occur at the loci analyzed, which suggests the Assateague Island herd is quite genetically diverse and harbors a high proportion of all domestic horse alleles.

The greatest genetic similarity among the island populations was between the Assateague Island and Cumberland Island populations, although there is no historic evidence to suggest they arose from common stock. When compared to domestic breeds, Cumberland Island horses were similar to Tennessee Walkers, while Assateague Island ponies were similar to Belgian workhorses and Shetland ponies. Since individuals of the latter breed were introduced into the Assateague Island population in the early 1900s, the similarity is not surprising. Comparison to other breeds suggests the island horses do not represent a unique gene pool from a common ancestral strain, nor are they more similar to one another than they are to various domestic horse breeds.

From a managerial perspective, the data indicate there is little reason to treat the barrier island horses as a unique or valuable genetic resource and little evidence that any of the herds represent a specific historic Spanish bloodline. This conclusion is supported by park records and oral history.

Efforts to outbreed and improve the coloration in the Assateague Island herd resulted in the introduction of Shetland ponies in the early 1900s. More recently, two Spanish barb stallions and 40 western mustangs were released on the island. On Hatteras Island there have been similar infusions of Thoroughbred, Arabian, Quarter Horse and Spanish mustang blood. The original Cumberland Island stock included saddle horses, circus horses, and western mustangs released in the 1920s as well as more recent arrivals, such as an Appaloosa stallion, whose progeny may still be seen in the wilderness area. The horses on Shackleford Banks probably derive primarily from stock brought to the island after the 1899 hurricane, and may be a mix of Hatteras Island animals, Quarter Horses, Tennessee Walkers and other breeds.

Although free range horses and ponies have been present on some of these islands since the colonial period, the present genetic composition of the herds does not appear to derive solely from relict early Spanish or English releases, but rather is the product of breeding activities conducted over the years by island residents. The Cape Hatteras horses, in fact, have a close genetic resemblance to Standardbred horses, a breed that developed in the United States in the late 17th and early 18th century. It would, in fact, be difficult to select the herd that is the most historic. All have recent genetic additions, and at least two (Shackleford Banks and Cumberland Island) may derive primarily from post-1900 introductions.

If feral equids remain on the coastal barrier islands

Continued on back cover

Lincoln Boyhood Vegetation *(Continued from page 22)*

green dragon, both species having toxic calcium oxalate (a deterrent to hogs), and poison ivy and the fact that the Lincolns had hogs. The forest showed no evidence for selective cutting of the overstory. Unlike the surrounding communities that were pastured in the 19th century, this stand lacked rank growth of Japanese honeysuckle. The other remnant was a small pin oak and bitternut hickory flatwoods at the western edge of the park. This remnant forest and xeric west-facing successional forests were similar in composition to presumed presettlement stands.

By the turn of the century, all the land surrounding the old growth forest was used for pasture. During the late 1920s or early 1930s a large portion of LIBO was reforested by the Civilian Conservation Corps. Plans indicated the intent of planting a wide variety of species; however the existing stand composition has low species diversity and fails to represent a natural community for this region. The overstory is a mixture of tulip tree and red or sugar maple. Sugar maple and tulip tree were introduced to the area at this time. The majority of the other forest types failed to compare with natural communities due to the predominance of shade tolerant and fire intolerant mesic species (such as red and sugar maple), the absence of oaks and hickories, the lack of herbaceous cover, and the ubiquity of Japanese honeysuckle.

Critical Management Issues

Critical management issues identified included the abundance of Japanese honeysuckle, vegetation inertia in abandoned homesites caused by exotic perennial lawn grasses, absence of oaks and hickories in the majority of the planted forests, the invasion of sugar maple and to a lesser extent tulip-tree into the old growth forest and the low abundance or absence of spring ephemeral herbs. Prescribed burning in some sections of the park may eliminate the invasion of shade tolerant and of fire sensitive tree species.

Management experiments to eliminate Japanese honeysuckle demonstrated that efforts may be most successful under a forested canopy where prolific growth is absent. Use of glyphosate may also eliminate the few herbs present in these anthropogenic communities, unless it is applied in the fall after herb die back. Trial plantings of spring ephemeral herbs indicated that ground cover restoration is possible. Glyphosate was shown to reduce the cover of exotic perennial grasses in old lawns and allow invasion of successional herbs. Although the herbicide fails to kill all of the grasses, a somewhat natural successional process has been initiated.

Oak trees (black, white and pin) that were planted in the old field showed deer browse, which may be why old field succession has been so slow. During the final sampling, seedlings of shingle oak were found and the presence of these was taken as a positive sign for natural establishment of large-seeded tree species.

Restoration priorities were based on a quasi quantitative numerical ranking system divided into the following categories: ecological significance, historical significance, relative restoration cost, urgency for and practicality of restoration. Although all categories were given equal weights, they could be weighted to give certain categories greater importance. Stands given high priority include the upland old growth forest and the bottomland forest.

Forest restoration to approximate the presettlement vegetation at Lincoln Boyhood will require a long-term concerted effort of management. Restoration will require innovation, creativity, and monitoring. Failures may be expected. Those attempting to achieve the vision of an approximate oak-hickory forest should not be discouraged by failures and setbacks. All such efforts will contribute to our knowledge of community restoration.

Copies of the 106-page report may be obtained from the Superintendent, Lincoln Boyhood National Memorial, Lincoln City, IN 47552.

Pavlovic, is Biostatistician for the Research Division at Indiana Dunes National Lakeshore, IN. His expertise is in experimental design, statistical analysis, and plant population ecology.

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Horses' Genetics ***(Continued from page 23)***

(the decision presently is made on a park-by-park basis), it would be desirable to maintain the populations at as small a size as possible to prevent vegetation damage. If the population is too small, however, and is isolated from other potential sources of new genetic material, in-breeding will result, which in turn reduces population viability. Estimates based on present sex ratios and harem composition for Cumberland Island predict that to maintain an effective population size of 50 animals, the total pre-foaling population must number about 80 animals. A study of feral impacts on salt marsh, conducted by the University of Georgia CPSU, suggested a vegetation carrying capacity of 45 to 75 animals. Adjusting for differences in harem size, a similar projection for Assateague Island National Seashore suggests a herd of about 100 animals is sufficient.

Regulated breeding and continued reintroduction of stock have maintained genetic diversity in the pony population at Cape Hatteras National Seashore, which stands currently at fewer than 30 animals. Further introductions probably will be necessary, and probably should be conducted with other island ponies. The same type of strategy would be appropriate for Assateague Island. Animals should, if possible, be from other island habitats and from populations with differing gene frequencies. Since the horses of Cumberland Island and Shackleford Banks are of relatively recent and very diverse origin, the use of mainland stock for outbreeding would be appropriate, and was a management technique utilized by island residents prior to park designation.

Genetic evaluation should be conducted prior to determining management strategies for feral animal species (or cultivated plants) assumed to be of historic significance. Genetic data may be used to determine the probable history of a population, its relationship to other populations, and the degree of in-breeding it may already have experienced. Genetic evaluation also adds scientific objectivity to potentially emotional issues such as the management of feral equids. Many techniques, such as electrophoresis, previously used only by a few progressive researchers now are widely employed and comparative data bases may already exist for domestic breeds or cultivars. These methods also are applicable to projects concerning endangered species with very limited or isolated populations and may be valuable in the course of population recovery or reintroduction projects.

The final report from this project has been submitted to the *Journal of Wildlife Management* for review. Further information is available from Robin Goodloe at the University of Georgia, Athens.

Bratton is Coordinator of the UIGA's NPS/CPSU; Goodloe and Warren are with UIGA's School of Forestry.

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